SILICON CHIP

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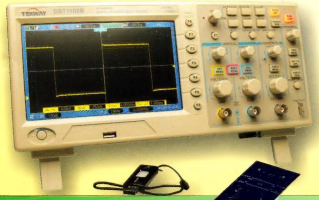
Simple, cheap 433MHz Sniffer Receiver

Cranial Electro Stimulator



We review:

TEKWAY DST1102 DSO –

Plenty of 'scope bang for your buck!

VAST:

HD Digital TV via Satellite

iPod® Cradle & Transmitter For In-Car Use

This lightweight portable charger and FM radio transmitter connects into your car's cigarette lighter to charge your iPod® or iPod® Mini. It allows you to listen to your iPod® tunes through your car's stereo radio.
AR-3118 WAS $49.95

Note: iPod® not included

$29.95
SAVE $20.00

In-Car Entertainment Headrests

With these 7" LCD Colour Monitor Headrests, kids can watch the same movie on two different monitors, or play different games on their X-Box® through the AV input. Both units come with a grey headrest, and both fit easily into your car seats.

7" TFT Colour Monitor with Headrest and DVD Player
- MPEG4
- Supports DivX/DVD/VCD/CD/CDG/MP4/MP3/WMA/JPEG
- Game functions (supports 8 bit & 32 bit game)
- Supports MS/MMC/SD cards
- Easy installation in most seats
- Headrest dimensions: 208(W) x 200(H) x 125(D) mm

QM-3776 $269

7" TFT Colour Monitor with Headrest
- Screen size: 7 inches
- Resolution: 234(H) x 480 (W) RGB
- Headrest dimensions: 208(W) x 200(H) x 125(D) mm
- Weight: 1300g

QM-3773 $199

FROM $199.00

Note: Requires external AV source.

New Year SAVINGS at Jaycar

SLA Battery Chargers

The Powertech Plus range of multi-stage intelligent battery chargers will suit almost any application. All feature rugged housing and output leads with both ring terminals and alligator clips to make battery connections a breeze. Safe to leave connected for months on end and suitable for most types of lead-acid batteries.

3-Stage, 6V/12V 0.75Amp, plug-in wall charger
MB-3603 $49.95

5-stage, 12V 0.8Amp/3.8Amp, multi-mode charger, IP65 rated
MB-3604 $79.95

7-stage, 12V-7Amp/24V-3.5Amp, multi-mode charger, IP65 rated
MB-3606 $149.00

9-stage, 12V-25Amp/24V-12.5Amp, multi-mode charger, IP44 rated
MB-3608 $499.00

FROM $49.95

OFC Pro Series RCA Car Audio Lead - 5m

Quality Oxygen Free Copper Series RCA audio lead with moulded gold plugs and central lead wire for remote switching of car amps, or for grounding on Hi-Fi home systems. Cable is figure 8 blue colour with an OD of 6mm each side. Plugs are gold plated mounted to the cable. Each lead has two RCA plugs on each end.

- Material: Oxygen free copper
- Centre conductor: 19 x 0.18
- Switch wire: 19 x 0.18
- Shielding: 112 x 0.12
- Shield type: Spiral
- Outside dia: 6 x 12mm
- Foam PE: 3.7mm
- Length: 5 metres

WA-1076 WAS $23.95

$19.95
SAVE $4.00

25mm Silk Dome Car Tweeter

25mm silk dome tweeter for car audio applications. Smooth, musical response up to 20kHz. Crossover included.

- Impedance: 8 ohms
- Frequency response: 1kHz - 20kHz
- Sensitivity: 91dB
- Power handling: 80WRMS
- Crossover dimensions: 72(L) x 39(W) x 21(H)mm

CS-2211 $24.95

VIFA Car Speakers

Vifa coaxials will add true high fidelity to your car audio system. All feature the legendary Vifa silk dome tweeters, strontium magnets and composite diaphragms. Available in 2 or 4-way configuration.

Vifa 5" 2 Way Car Speakers
- Power handling: 60WRMS
- Nominal impedance: 4 ohms
- Frequency response: 50Hz - 20kHz
- Sensitivity: 87.9 dB SPL @1W, 1m

CS-2393 WAS $99.00

$79.00
SAVE $20.00

Vifa 6.5" 2 Way Car Speakers
- Power handling: 80WRMS
- Nominal impedance: 4 ohms
- Frequency response: 45Hz - 20kHz
- Sensitivity: 86.3dB SPL @1W, 1m

CS-2395 WAS $129.00

$119.00
SAVE $10.00

Vifa 6 x 9" 4 Way Car Speakers
- Power handling: 150WRMS
- Nominal impedance: 4 ohms
- Frequency response: 35Hz - 20kHz
- Sensitivity: 90 dB SPL @1W, 1m

CS-2397 WAS $189.00

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SAVE $20.00

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Vifa's patented Hearing Optimised Driving (HOD) technology accounts for harsh in-car audio environments and drastically improves the sound production quality of your car audio system. Featuring super strong strontium magnets, Vifa's patented complex cone design, 36mm silk dome tweeter and a butterworth crossover circuit; these component split systems reproduce unparalleled crystal clear sound that sounds more home theatre than car audio.

Vifa 5" Component Split Speakers
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50Hz-20kHz
CS-2398 WAS $179.00

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Vifa 6.5" Component Split Speakers
80WRMS @ 4 ohms
45Hz-20kHz
CS-2399 WAS $199.00

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Publisher's Letter

Gas-fired trigeneration is a worthwhile concept

While you may be concerned about your ever-increasing energy bills, there is another electricity problem that may soon confront a lot of Australians: power blackouts. The truth is that all the eastern States have a chronic shortage of electricity generators. For a variety of reasons, the States have not been building new coal-fired power stations and they are increasingly using the available generation capacity. And while they have been trumpeting wind farms and roof-top solar installations, these will provide a very small fraction of the total demand.

It will only need a series of very hot days this summer or perhaps a major power station or grid fault to cause some serious blackouts. And since all the eastern States, including Tasmania, are interconnected, the blackouts could potentially be state-wide or even more extensive.

There is no easy solution to this problem. Since there is a lack of generating capacity and since everyone with an air-conditioner is likely to run it whenever the temperature rises, the result is likely to be power rationing to wide areas or worse, the blackouts may be sudden and widespread. Or maybe the authorities will be proactive and if very hot weather is predicted, they may appeal to consumers to curtail their use of air-conditioning.

All of which makes a recent proposal by Sydney's Lord Mayor, Clover Moore, all the more interesting. Ms Moore is proposing that all of the Sydney CBD should be powered from small gas-fired trigeneration plants. Undoubtedly, this is partly to appeal to inner-city "green voters" anxious about "carbon emissions" but it makes a lot of sense anyway.

While many readers are probably familiar with gas-fired co-generation plants, they may not be familiar with trigeneration, which is not a new concept, incidentally. Co-generation refers to a plant which typically has a gas-fired turbine running an alternator to generate electricity. Waste heat from the exhaust of the gas turbine is then used to flash water into steam to drive a steam turbine and alternator to generate more electricity. Trigeneration typically takes waste heat from the water condensate of the steam turbine to run an absorption refrigeration system for air-conditioning. Other variations use the waste heat for heating in a building.

Whatever variant is used, it is a great deal more efficient than coal-fired power stations or gas-fired co-generation plants and that means that far less hydrocarbons are burnt to generate a given quantity of energy, so that is a big advantage. Furthermore, the proposed trigeneration plants would be installed in existing buildings and would no doubt be able to be brought on line much more quickly than any large conventional power plant.

The concept also has the advantage of being a local power source which means that there are less transmission losses from the point of generation to where it is used.

Of course there has been criticism of the idea. One problem to be solved, apart from matters like planning regulations and finance, is the large quantity of natural gas that will be required and whether existing supplies in the city will be adequate. And some people have been concerned about the amount of local pollution that might be created by these gas-fired plants. I would say, "Don't worry about it!"

After all, any pollutants generated by clean-burning gas turbines are likely to be minimal compared to those from all the diesel-powered standby generators already present in the central business districts of our State capitals. Many of those standby generators are already committed to the grid via lucrative contracts with electricity distributors.

So if you notice a haze over your capital city during hot days this summer, it could well be due to those diesel generators.

Maybe we really should consider nuclear power!

Leo Simpson

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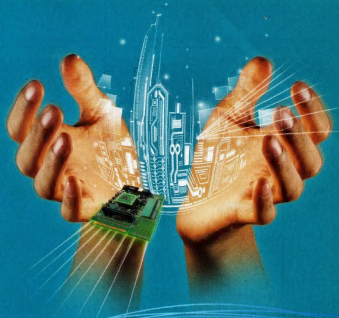

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Audio delay for sports commentary

As the cricket season is upon us I find myself turning down the volume on the TV and tuning in the radio to the ABC. I then run this signal through the following software to get the two in sync: **http://www.daansystems.com/radiodelay/**

Looking at your DAB+ radio project, it struck me that there is plenty of room in the case to fit a hardware version of the above software. The most delay I have ever had to apply is 4.5 seconds so not a lot of RAM would be required and it should be within the processing power of the current range of PICs. Or how about a standalone version?

Rob Chandler,
Clayton North, Vic.

Comment: thanks for the suggestion. In fact, because DAB+ radios buffer the digital signal, they can produce a significant delay and it varies from model to model. We checked out our own DAB+ tuner and found the audio delay to be close to 10 seconds.

By the way, if you like to participate in radio phone-in competitions, that order of delay will put you out of the running.

Ideas for recycling

I was wondering what happened to the recycling section of your magazine. I though that it might be because of a lack of ideas, so I have included some in this letter. I have used the LED strip light out of an old fax machine for a night light now for a few years. I reconfigured it to work on 5V and powered it from an old mobile phone 5V regulated plugpack.

I also have replaced the 509 batteries in some of our Dolphin torches with 6V 4Ah SLA batteries. You have to fit a 6V bulb and a DC socket. I charge them with an old mobile phone 8V regulated plugpack. I install a 1N4004 diode between the DC socket and the battery to drop the voltage to 7.3V. I have been using this set-up for years.

My latest project was to make up a surround sound system for my computer. You are not supposed to connect speakers directly to the motherboard (Gigabyte GA-H75M-USB3), so I asked in the shops whether there was an amplifier on all the speakers in their systems and they said no. Also there was a price tag of around $150. Now I have wrecked a number of TV sets that people have thrown out and they have perfectly good amplifiers. The chips in nearly all of them are either a mono AN5265 or a stereo LA4282 (the specifications are available free on the internet).

I used the LA4282. The transformer is out of an old VHS recorder, the bridge rectifier and filter capacitor from an electric typewriter and the rest out of TV sets. I am well pleased with the result and think that this sounds better than the ones I heard in the shops.

Ron Groves,
Cooloola Cove, Qld.

Comment: basically, we stopped the Recycle It section because we ran out of ideas, although the drill conversion story in the December 2010 issue and the PC power supply conversion article in this issue are really a continuation of the same theme.

The circuit of your recycled ampli-

Analog audio outputs for large flat screen TVs

I have been belatedly reading the July 2010 issue which contained both the Publisher's Letter and a Mailbag letter lamenting the lack of analog audio outputs on flat-panel TVs. We purchased a base model Sony Bravia LCD TV in May 2010 and this does have analog outputs.

This was a consideration in deciding which set we purchased. Although we initially tested the analog outputs via our early 1990s vintage 2.0 channel surround sound system (aka stereo amplifier and speakers), the sound quality from the TV's speakers is surprisingly good so we did not persist in using the external sound system.

Another point mentioned in the Mailbag letter is that the TV remote can't usually control the volume when using an external sound system. Fortunately, the Sony TV is not subject to this problem as the analog outputs can be configured to either be at constant level or variable level; ie, they still respond to the TV's volume and mute controls. Another way around this problem is to use a programmable remote control – we have a Logitech 525 – and remap the volume and mute buttons normally used for the TV to send the corresponding IR codes which suit the external sound system.

While the Logitech software does not allow IR codes to be cut and pasted between various devices, it is possible to use the "learning" feature to add specific commands for other devices to a target device, using the original remote; eg, in this case the remote for the sound system. The original IR codes for the TV volume and mute can be allocated to other buttons on the remote, so they can still be accessed if needed. The Logitech 525 remote has provision for several "pages" of commands to be allocated to the upper LCD section of the remote, which caters for four commands per "page" with corresponding buttons, so this is a good place for lesser-used commands.

Also see **http://htpcmacmini.blogspot.com/2010/09/using-2010-mac-mini-as-home-theatre-pc.html** for setting up a Logitech remote to control a Mac Mini home-theatre PC.

Richard Stallard,
Nedlands WA.

fier and accompanying regulated power circuit is featured in the Circuit Notebook pages this month.

Hints & tips on cordless drills

I had been working on an "article" around recycling cordless drills when the battery gives up and what did I see in December issue but your excellent article on the same subject! Still, I have a couple of suggestions that readers may find useful.

I decided many years ago that I could use the drills with a lead to an external battery and that would allow me to retain their advantages of: (1) low speed for good control on jobs where finish was an issue, ie, not marking a finished surface by a screw driving bit skipping out of a screw; (2) high torque at low speed for driving screws; (3) light weight (once the battery was removed from the drill); and (4) safety (it is powered by say 12-24V) – particularly relevant if using a drill on car repairs/restoration.

I disassemble the battery pack and fit a lead to the original termination points in the battery case so that it plugs in exactly as before. So far with some patience I have been able to solder OK to the metal that is used. I fit the lead with one of the 32V/15A polarised plugs from HPM or Ring Grip. I mount the battery to a small wooden base and the base has a cover to stop the terminals being accidentally shorted by a falling tool. I fit a fuse rated at 20A and a 32V/15A line or chassis socket. I take great care to maintain the correct lead polarity as any drills with a variable speed facility will not react well to reverse polarity (as noted in the article).

For a connecting lead I have used 250V 10A figure-8 cable and it is OK for lengths of say 6m. If you would like to use a tough cable to stand heavy boots then buy some garden lighting cable – just be sure to mark the positive and negative leads clearly with coloured cable ties so they don't get mixed up.

The power source required varies with the drill. If the drill was 12V or 24V then that's easy. Old car batteries will often do the trick and can be used singly for 12V or two in series for 24V. They work very well and are easy to recharge. I connect the batteries in series with the 32V/15A plugs and sockets mentioned above and that allows me to easily charge them separately from a 12V charger fitted with the same plugs.

For an 18V drill I use three 6V SLA batteries from Super Cheap Auto and wire them up in series, to give 18V. In my case the 18V drill was a very costly AEG with an excellent charger so I wired the lead to the internal connections in the original slide-on battery holder and I use this to plug onto the charger to recharge the external battery pack, again via 32A/15A plugs and sockets. The drill has a torque rating of 68Nm and the three batteries run it beautifully.

In the case of small folding "screwdriver-only" tools that typically run off 4.8V, I have set one of these to run from a 6V battery and it is excellent. My car battery charger has a 6V setting so that's easy.

We have run an old Ryobi 9.6V drill from 12V for about 15 years now and it will drive in 12/14G roofing screws.

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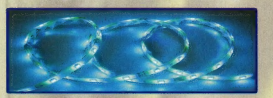

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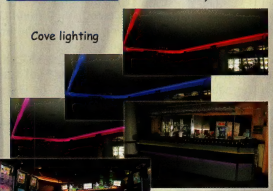
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Mailbag: continued

Project designs not always perfect

I wish you would be more considerate of us poor kit constructors when you first publish a new project. Specifically, I have just spent a lot of time building the October 2009 project "Digital Megohm & Leakage Current Meter" only to find that it was found to be unsatisfactory and improvements were published in the June 2010 issue under a different project name, "Digital Insulation Meter".

The kit I bought was for the original design and it is hard to complain to the supplier when they followed your design faithfully at a good price, with the best of intentions. In fact, it replicates very well the faults described in the June 2010 issue.

You are, justly, very good at picking faults with others but I suggest that you look in the mirror sometimes as well. A bit more testing time before publishing the first project would have disclosed the problems. Then, having decided to re-design the thing, the designer should have promptly notified the trade and consumers that there was something better coming so they could hold back. The updated project was not announced on the cover of the June 2010 issue and it was well back in the magazine at page 78.

To further conceal its ancestry it was given a different name, rather than "Mark 2" or similar. As far as I can see there has been no attempt to use the "Notes and Errata" column or similar to flag the faults.

There was a similar situation in 2009 when the "Mk.2 Universal Motor Speed Controller" was published. It worked but had a few issues like not running up to full speed. Kits hit the shops fairly quickly and no doubt sold well. Then only three months later, in May 2009 the new "230VAC Full-Wave Motor Speed Controller" was published and it did everything right.

Eventually, both kits were sold but we have to pity the retailers left with old stock of the first one and consumers who bought them.

Kit construction is good fun and many of us want to keep doing it but these shortcomings bring a bad reputation.

Bruce Rabbidge,
St Ives, NSW.

Comment: in the case of the projects you mention, we would plead guilty in the case of Digital Megohmmeter (October 2009) as it did become evident that it had drawbacks. However, when the problems were brought to light, we did contact the suppliers concerned. Nor did we keep the drawbacks secret since they were mentioned right at the start of the Digital Insulation Meter article in June 2010.

On the other hand there was no fault in the Mk.2 Universal Motor Speed Controller. It was a half-wave controller and we stated right up front that it would not run the motor at full speed but at about 80% maximum. The vast majority of speed controllers used in AC power tools operate on exactly the same principle.

The full-wave speed controller was a much more complex and expensive design and would not be justified in many applications. Both speed controllers are valid designs.

I suspect it has a 12V motor like many drills so a 12V supply is no problem.

Using a car cigarette lighter plug is good if you carry it in the car/boat but I am dubious about the long term reliability of those plugs at higher currents. The 32V/15A plugs and sockets are excellent.

I make up extension leads with garden lighting cable and even at 10-12m total lead length, I don't notice any real difference in performance unless I am working the drill at maximum effort on say a 200mm batten screw.

Ranald Grant,
Bellbowrie, Qld.

The NBN: stop arguing and get started

The debate is over – the NBN will be built. The senate has passed legislation for the structural separation of Telstra.

At a conference in 2005 in Adelaide the then Shadow Minister for Communications Stephen Conroy listened to a presentation about the broad potential of telecommunications infrastructure and the widespread social and economic benefits that

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Solar power feedback

In response to your request for feedback on installed systems, we have had a 1kW system in use for just over a year.

The installation comprises six 175W solar panels and an 1100-watt grid-connected inverter. The highest noted power output was 1023W one day last week. Previous inspections have shown readings of 800-900W. We have no data-logging facility, so it is only when we think to look at the display when passing by that readings are noted.

In total, the system has generated over 1100kWh since installation, so that is about 1000kWh per year.

Don Riley,
Qualigo, NSW.

Comment: at 60 cents/kilowatt hour, that amounts to around $600 per annum in offsets to your electricity bill. We wonder if that grid feed-in tariff will be maintained long enough to recover your investment.

high-speed broadband could bring to the community. From that moment on, Minister Conroy has been on a mission and it is absolutely remarkable that, despite the many hurdles, Australia will now be the first country in the world to start building national digital economy infrastructure for the next generation of Australians. Full marks to the Minister – he has been the key driver of the process.

For those who are arguing that this is all too difficult; that it is no more than an experiment; that it is an article of faith; that we cannot do it because there are so many associated problems, I would say look at the Sydney Olympics.

At times it has been politically messy and there were occasions when even the staunchest supporters of the NBN questioned the way things were being handled. But the government and its supporters never lost sight of the end goal. Every time problems appeared they were solved and the project continued, culminating in the passing of the all-important legislation.

The successful passage of the legislation also reflects the broad support that exists for the NBN. It has twice been an election issue and arguably was the major contributing factor in the thin Labor victory. For the last five years the industry members have almost unanimously put their weight behind it and many hundreds of telecommunications professionals have worked voluntarily within the Digital Economy Industry Work Group and Communications Alliance to assist in developing strategies and technical, regulatory and commercial plans, as well as addressing many other elements of the NBN.

Research shows that 70% of Australian consumers and medium-sized business are NBN-ready. They understand what the NBN can do and they want it.

While some executives in the corporate business community question the financial aspects of the project they are also very supportive of the concept behind it. Equally the plans received broad support from consumer

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Mailbag: continued

Don't squander the opportunity to build the NBN

I am writing to comment on the recent editorial coverage about the NBN in SILICON CHIP.

There are real and serious issues at present around a lack of sufficient public information and public understanding of precisely how the NBN is going to work, how costings will turn out and around (in general) a variety of key policy settings for the network that are up in the air. No argument there.

However, an NBN built with the wrong policy settings is capable of having those policy settings fixed later. But an NBN that is never built is incapable of being "fixed" later.

Yes, I'm in favour of the NBN. I think the best future involves an Australia-wide fibre network and 3G/4G wireless. They're complimentary and they don't conflict (consider, for instance, the benefits of the widespread use of femtocells on fibre-connected residential fixed services). It's a win-win.

We have an opportunity to create a future-proof fibre optic fixed line network for our children – and theirs. And we have the potential to squander that opportunity. I don't think we should squander it.

Simon Hackett,
Managing Director, Internode.

organisations and the unions. And after decades of antagonism between the industry and Telstra, the national telecoms carrier also gave its support to the NBN and worked with the government and the rest of the industry in making it a reality.

Finally, the regulators, ACCC and ACMA, have been very positive about the NBN.

Given that so many believe that the national broadband network is a good idea, there is no doubt that, in the same cooperative way, all involved will ensure that it becomes an historic nation-building project. It is true that $35 billion is a lot of money but it will be spent over a decade or so and that makes it a very acceptable government investment. And in the end the government will get its money back, so it is a true investment in the country for the generations that are growing up now and for those who will be following them – as well as for those of us today who are looking forward to better broadband services.

Half a dozen electricity companies are currently involved in technical trials with NBN Co, looking at combining smart grid and NBN infrastructure. This could lead to savings for the electricity companies of around $2 billion – while at the same time it will allow users to obtain better information about their energy use, enabling them to better manage their electricity use and thus save costs.

Most Australians wanted the NBN to happen and they were growing tired of the debate. The message clearly was: stop arguing and let's get started.

Paul Budde,
Paul Budde Communication Pty Ltd, Bucketty, NSW.

Comment: the last time we looked, Labor did not win the 2010 Federal Election but they managed to put together an arrangement to govern in conjunction with the independents and the Greens party. It is true that some enabling legislation for the NBN has been passed but the debate about the cost and implementation is far from over.

We also note that the ACCC has just urged the Gillard government to reject the NBN's monopoly plan with its restricted interconnection points.

For that amount of money, we would rather have a Very Fast Train system, connecting Brisbane, Sydney, Canberra and Melbourne. We could probably get a few major hospitals and power stations thrown in as well.

Disappointment with DAB+ sound quality

I have been listening to radio via a DAB+ tuner (Digitech, Jaycar AR1753) and my initial reaction is disappoint-

ment. I listen mainly to 702 on the AM band and my subjective feeling is that the digital product is not as good as the AM product received on my wideband AM tuner (Audiosound Labs T751).

Have you ever published, or might you plan to do, a review of DAB+ receivers/tuners, particularly the hifi component type. Small hand-held radios and clock radios sound no different from their analog counterparts to me, probably due to their tiny speakers. Are all DAB+ tuners created equal due to digital technology?

It might be interesting also to have a radio industry engineer do an article on any differences in signal processing for the two mediums prior to transmission because the Digital 702 sounds artificially flat and quiet to me and the news theme seems to "pump" when compared with AM. With the radio industry all trumpeting how good DAB+ is, maybe they should make an effort to make it come true!

Robert Allan,
Hunter's Hill, NSW.

Comment: first of all, not all DAB+ radios are created equal. You have already noted that small handheld radios and clock radios have small speakers but there are plenty of other circuit reasons why their audio quality may be inferior.

DAB+ sound quality is potentially very good in a high-quality design – look no further than our own DAB+/FM radio described in the October, November & December 2010 issues.

LEDs can last a very long time

Thank you for producing a truly amazing magazine. My question is: What is the longest time you have heard of in the " life span " of a red or green LED sitting across the 240VAC mains supply. You know the simple circuit, involving a 0.47µF 250VAC capacitor, three 120Ω series limiting resistors and a reversed diode across the LED. I installed such a LED circuit behind every light switch (with the LED poking through the plastic switch plate) back in 1982 when we moved into our new home.

We had no street lighting or even new neighbours at that stage. On moonless nights we could not find the light switches, so LEDs came to the rescue. These LEDs (green for the hallway and bedrooms and red for two switches in the lounge) were installed on February 20th, 1982. That is an incredible 250,000 hours. The LEDs have lost some of their original brightness, however they all still illuminate well. The brand was Stanley of Japan. Outstanding!

Jeff Rose,
Unitech Electronics Pty Ltd,
Minto, NSW.

Comment: no one really knows how long LEDs can last. Figures in excess of 100,000 hours are often mentioned but we have often thought that the manufacturers cannot know this when the devices are made. So your experience is a very encouraging indicator.

One of the first uses of a LED in an Australian electronics magazine project was for the pilot light of the very popular Playmaster Twin-25 stereo amplifier published in the April 1976 issue of "Electronics Australia". We wonder how many of those amplifiers are still in use today.

However, there is another problem with DAB+ and that it is the data bit rate used for transmissions; it is simply not high enough for most programs. For ABC 702, the data rate is a measly 64kb/s. Worse still, ABC Classic is only 80kb/s when it really should be at least 160kb/s. By comparison, TripleM is 96kb/s and 2UE is 128kb/s.

For very best quality, the sampling rate should ideally be 256kb/s but as far as we know, no Australian DAB+ station gets anywhere near that figure.

On another point, your comparison of DAB+ audio quality on ABC 702 with AM reception on Audiosound Labs' T751 is the worst possible – for DAB+. The Australian-made Audiosound was one of the best AM tuners ever produced. Not only does it have very low distortion and a good signal-to-noise ratio (particularly if used in conjunction with a noise-cancelling loop antenna) but it also has very good audio bandwidth, rivalling that of good FM stereo tuners.

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Mailbag: continued

Many solar power systems may be incorrectly installed

In August 2010, my family signed up for a 2kW solar system. The calculations estimated that this system would supply 50% of our electricity usage. Our annual consumption is under 6000kWh per year.

During late September, the contractors turned up unannounced to install the system. Luckily for me, I was on a "Rostered Day Off" this particular day. So I poked around the new equipment, photographed everything there was (serial numbers and specs of the panels) and "read" the inverter manual.

That gave me an idea as to how the system would be wired up. Watching almost every move of the electrician and his helpers, I noted what they were doing. Comparing what they were doing with what I had in mind varied considerably, so I questioned the electrician as to how he would wire up the 2kW worth of panels. The inverter has two inputs with a rough maximum of 1kW each.

He replied that he was going to wire all 12 panels in series. I went back and doubled-checked the manual – this idea of his wasn't possible. The maximum voltage the array can produce is well over the maximum that one input on the inverter will handle. I put that to him, with the suggestion of two strings of six panels and the reasons why. He did some quick maths and agreed. I was glad I'd intervened!

Then when he was running the cables, I could only see one cable (two conductors) from the array to the inverter. That concerned me, so I again questioned the "electrician" as to his intentions. He said he would parallel the two strings up at the roof level and just run one single cable down.

My quick maths concluded that the current the two arrays could produce would be in excess of the single inverter input. I suggested that the two inputs on the inverter should be used, with each 6-panel array running to the inverter. He was not initially receptive of my query but the cogs were turning.

Eventually, he started to agree but walked away to ring his "mate" for further advice. A few minutes later he returned and was totally in agreement with running each 6-panel array to the two inverter inputs. He also advised that he has "never connected the solar panels like that before" and implied that he didn't know what the extra terminals on the inverter were for.

I was worried but also relieved that I had been watching what was happening. I didn't question his mains-wiring, he seemed to be in his comfort zone on this side of things.

Due to the nature of our roof, the arrays could not be mounted as they

In general, the sound quality from DAB+ radio is satisfactory. It has no noise breakthrough and no multipath problems that can plague FM reception. But when a DAB+ program is directly compared with the same program on a high-quality FM stereo tuner (with no multi-path problems), the FM quality will probably win out. Let us hope that DAB+ program originators decide to go to higher data rates.

We had a series of articles on DAB+ principles in the February to August 2009 issues and the topic of reception quality has been commented on, sometimes very critically, in the Mailbag pages during 2010.

No point in rewinding microwave oven transformers

I have periodically seen letters on people modifying and re-using microwave oven transformers. From my own experience, these transformers are virtually useless for anything other than a microwave oven.

I also experimented with these many years ago and found that on at least two tries, they worked but they would hum excessively and draw considerable current from the mains even though there was no load connected to the (rewound) secondary. Even with no secondary winding, this would occur. At the time I was puzzled as to why

apparently expected to. They have a standard kit of parts which wasn't enough for our roof – obstacles had to be dodged (kitchen chimney and sky-lights). So they did what they could, with my assistance, and departed that evening with an incomplete installation. Later that evening, I flicked through the photos I took of the panels. What I didn't notice at the time was that one of the panels was a 165W model while all the others were 170W; another issue to sort out.

A couple of weeks later, they returned unannounced again, to finish off and replace the "stray" panel. My wife contacted me by telephone to advise of the progress but they were having trouble. I'm not sure what happened but after personally speaking to the electrician (after he acknowledged that I knew more about it than him), they could not get it all working. "Grid fault" was the message on the inverter. Another electrician attended later (his "mate") to sort it out. There was some issue with the mains wiring to the inverter as well! He fixed that up in minutes.

Then the new meter was spinning and the Sun commenced producing power for us. Who knows how many other systems have been incorrectly installed, not giving optimum output or worse? Sounds a bit like the home insulation scheme? I'm glad I "wasted" my RDO to guide the "qualified" electrician, even though I only have an "electronics trade" certificate and am not qualified to install these systems.

An informative LCD screen on the inverter tells us many statistics. To date (55 days), the system has produced 451kWh and the average = 8.2kWh day, which is as designed. The maximum on any one day has been over 13kWh (around 12 hours of running on that day). The minimum noted has been around 2kWh for a fully overcast and rainy day (during spring). Today (very wet and overcast all day) has yielded 3kW/h (beginning of summer).

The nominal maximum array output is 2040W. The maximum instantaneous power I have noted it generate is 2138W. That was at the ideal time of day and with a very light hazy cloud. With a perfect clear sky, at the best time of day, the output is generally around 1800-1900W. Coincidentally, our first electricity bill just arrived – a grand total owing of $1.11.

Funny how our electricity cost has also increased from $0.19525 to $0.20823 per kWh (including GST) at about the time permission was granted by the electricity provider to allow our system to be installed? Based on today's electricity prices (sure to rise before the next bill!) the pay-back period should be 2-3 years as we just scraped into the generous $0.60 kW/h rebate scheme ($0.68 with AGL) that was recently reduced to $0.20 in NSW.

Robert Parnell
St Clair, NSW.

this was happening but the answer came to me in an "Electronics Australia" article (May 1988) titled "What's Inside Your Microwave Oven".

The article describes the type of transformer used in microwave ovens as a "leakage transformer" which is designed with leakage inductance to provide current regulation to compensate for various loads (types of food) and mains voltage (I think I got that right). This is normally achieved by providing an air gap in the transformer core, which (I assume) is the problem as this would sacrifice efficiency.

I cannot state that all microwave oven transformers are constructed this way but for what it is worth, this is what I have found.

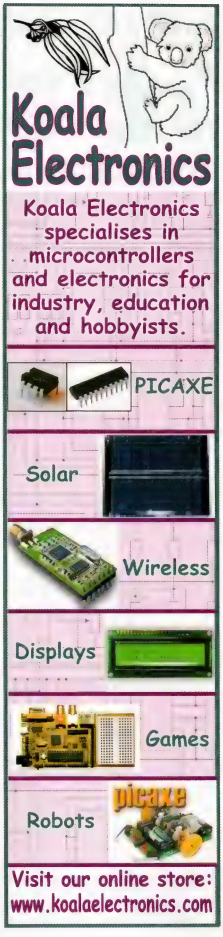
Thank you for a consistently informative and enjoyable magazine

Grant Saxton,
Cambridge, NZ.

Comment on Publisher's Letter

Just a note to say I really enjoyed reading Leo Simpson's comments on the NBN. He speaks as he sees it – boldly – with a clear argument. Thank you Leo and to your team in making a truly world-class publication.

Rob Prince,
Tea Gardens, NSW. SC



Analog TV - going! Aurora TV - going! What's next?

It's VAST!

Back in April last year, the Australian Government announced a landmark agreement that will eventually provide high quality digital TV services to viewers who cannot receive terrestrial digital TV (ie, digital TV services from transmission towers in their area).

by Garry Cratt*

Viewers in most areas of Eastern Australia are now, or will soon be, able to receive the full range of digital TV programming from the new digital TV satellite service that their city cousins have come to expect.

The new service is called VAST: Viewer Access Satellite Television and is operated by Southern Cross Media and Imparja.

Funded by the Australian Government, it will ensure access to high quality (SD and HD) free-to-air TV delivered by satellite for viewers living in all areas not covered by a digital terrestrial TV tower.

The VAST service will operate in northern and southern time zones, providing services for viewers in Queensland and the Northern Territory based on Brisbane time and services for viewers in NSW, Victoria, South Australia and Tasmania based on Sydney time.

Vast will deliver the following 17 digital channels:

High Definition:	One HD Nine HD, Seven HD, SBS HD, ABC News24 HD
Standard Definition:	Regional Local News ABC1, Imparja, Nine, SBS One, Southern Cross Seven, Ten ABC2, ABC3, GO!, SBS TWO, 7TWO, ONE

Table 1: VAST access availability by region

Region	Digital Switchover Date	VAST Access Available From
Mildura/Sunraysia	30 June 2010	June 2010*
Regional SA & Broken Hill	15 December 2010	September 2010
Regional Victoria	5 May 2011	15 December 2010*
Regional Queensland	TBA; Second Half 2011	6 Months before Switchover Date
Regional Southern NSW	TBA; First Half 2012	6 Months before Switchover Date
Regional Northern NSW	TBA; Second Half 2012	6 Months before Switchover Date
Tasmania	TBA; First Half 2013	6 Months before Switchover Date
Perth	TBA; First Half 2013	6 Months before Switchover Date
Brisbane & Gold Coast	TBA; First Half 2013	6 Months before Switchover Date
Melbourne	TBA; Second Half 2013	6 Months before Switchover Date
Adelaide	TBA; Second Half 2013	6 Months before Switchover Date
Sydney	TBA; Second Half 2013	6 Months before Switchover Date
Darwin	TBA; Second Half 2013	6 Months before Switchover Date
Remote Central & Eastern Australia	TBA; Second Half 2013	15 December 2010*
Remote Western Australia	TBA; Second Half 2013	TBA

* Not all channels available at this time

A "slimmed-down" channel lineup consisting of ABC and SBS services has been available to customers living in the TV1 licence area (Remote Central and Eastern Australia – see map overleaf) since December 15th, 2010.

The satellite service for viewers in Western Australia is currently under negotiation with Prime and WIN Television and details will be released soon.

So it is obvious that remote Australia will not only get a more reliable service with VAST, their choice of programs will also be significantly expanded.

Who is eligible?

The service is primarily designed for viewers who live in geographic regions that won't be covered by digital TV signals when the analog TV signals are turned off. It is quite possible (indeed likely) that many viewers is deep fringe areas who are "only just" receiving an analog signal at the moment, will not receive any digital signal at all.

Digital TV signals have a very distinct level threshold (known as the digital cliff), beyond which reception will not be possible.

A satellite-based delivery solution was a considered a much more economical solution than upgrading or building new "black spot" TV transmitters in every region affected.

In these regions viewers will have access to the new VAST satellite service six months before the analog TV signals are scheduled to be switched

The VAST-ready UEC set-top box is currently the only approved model on the market, although that is expected to change as VAST becomes more widely available. It offers HDMI output, is Dolby Digital compatible and as can be seen from the rear panel photo below, is very comprehensive in its functions. Each STB has its own VAST smartcard – cards cannot be swapped between machines.

off (see table 1 for details) to give enough time to check reception and if required, have the VAST systems installed. If viewers live in an area that was previously service by an analog self-help transmitter then there will be the added bonus of the Australian Government offering to help with the financial cost of installing a new VAST service.

For more details regarding the subsidy scheme see www.adreesgoeshere.com.au.

From this, it is obvious that viewers living in areas that are deemed to receive acceptable signal levels from a digital TV transmitter will be unable to apply for the VAST service. Maps of each transmitters theoretical coverage area are available on the web. However, even those inside these theoretical signal coverage areas who can't receive digital TV signals ***will*** be able to apply to receive the VAST service via the ACMA or their local TV antenna technician.

Existing Aurora viewers who either live inside ACMA classified TV1 license area or viewers who had previously applied for blackspot satellite TV reception via the ACMA were able to purchase a new VAST set top box and apply to receive the service from the 15th of December 2010. A detailed map of the TV1 license area in shown overleaf. (A much larger scale map is available on the website (www.acma.gov.au/WEB/STANDARD..PC/pc=PC_90223). New viewers who live inside the TV1 licence area detailed above are also now able to purchase a VAST system or VAST setup box and apply to receive the significantly increased channel line up.

You might be wondering why all of the regions listed in the table opposite do not have immediate access to VAST.

In truth, they do – but only for ABC and SBS. The area-by-area release is designed to mimic the digital switchover (and end of analog services) which is progressively occurring throughout Australia. So as an area is readied for digital, it will (six months before) also have access to VAST.

The point of the exercise is to gradually provide HD digital quality to all areas, so all those people who have gone out and bought new HD screens will finally have something to view on them which justifies their purchase! At the moment, if they're re receiving Aurora, it's only a standard definition, with a mono sound signal.

Travellers?

A traveller's allowance such as the one which exists for Aurora customers has not yet been announced for VAST. However, it is anticipated that this will come in time, especially given the fact that Aurora is scheduled to run only until the end of 2013. At this point all analog terrestrial television will also have been turned off.

Given the numbers of travellers with satellite dishes on their motor homes and caravans, there would be a huge outcry if the daily dose of news and (more importantly!) soap operas sud-

The TV1 licence area is shown above in grey. It's within this area that Aurora reception has traditionally been allowed. The straw-coloured areas of the map are areas (at least theoretically!) served by terrestrial TV stations, even though many viewers in these areas have poor reception at best and often much less. With appropriate receiver and dish, anyone in this area will now have at least HD ABC and SBS access. By the end of 2013, VAST will offer 17 HD channels across all areas.

These coverage maps highlight the VAST roll-out dates in South Australia and Victoria. As you can see, parts of regional SA, Broken Hill and Mildura area have already commenced, with regional Victoria scheduled for the next few months.

denly disappeared!

How do you access VAST?

To access the service, you will need to purchase a satellite set-top box, a satellite dish of at least 65cm (85cm is recommended) a low noise amplifier (LNBF), a mounting post on which to install the dish, and some cable.

Access to this new satellite service will be managed by the use of subscriber 'smart cards', included when you purchase your new satellite set top box. Smartcards will be matched to each satellite receiver and will be available as a package for $269.00.

Currently UEC has the only approved set top box on the market. They are available from most reputable satellite equipment retailers.

The VAST service uses the Optus C1/D3 satellite which means most customers who already watch the Aurora services won't need to re-point their dish. VAST is broadcast using the DVB-S2 standard which allows for high definition broadcasts.

Once the equipment is correctly installed, viewers should be able to receive ABC and SBS TV without registering the smartcard which accompanied the set top box.

However to access the full range of commercial services, viewers will need to register their details, which must include a site address within the approved areas. This can be done online or via the form included with the VAST set top box.

In time, it is hoped that even the site address requirement will be lifted.

When can you start watching?

Communities relying on self-help TV

towers in other regions will be able to access the scheme on a region-by-region basis. Regional South Australia was the first switchover area to open for the Satellite Subsidy Scheme in July 2010. Other areas opened from November 2010 .

According to the ACMA website (www.digitalready.gov.au/rolloutmap.aspx), the first areas of Australia to have Digital Television Service implemented are Regional South Australia and Broken Hill, rolled out from December 15 2010 onwards.

As can be seen from the accompanying maps, the areas covered by the December 15 commencement were Broken Hill, Renmark, Loxton, Mt Gambier, Naracoorte, Bordertown, Port Lincoln, Whyalla and Port Augusta. Customers living in these areas will have access to the full VAST line up.

Next up will be Regional Victoria, which will be rolled out by June 30 2011. This includes Bendigo, Ballarat, Swan Hill, Traralgon, Bairnsdale, Malacoota, Albury/Wodonga, Wangaratta, Shepparton, Warnambool and Horsham.

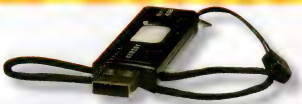
And if you already watch the Aurora Service?

ACMA advises that the Aurora service will continue to run until the end of 2013 when the national digital rollout is completed. Prior to this, the VAST service will operate side by side with the Aurora service.

It is expected that between now and then, Aurora viewers will make the switch to digital by purchasing a VAST set top box. Many may run VAST and Aurora receivers side by side in the interim. In most instances, no new dish or cabling will be required. *SC*

* Technical Director, Av-Comm Pty Ltd

TEKWAY DST1102B W



Review by JIM ROWE

A little over 17 years ago, I realised that if I wanted to continue designing electronics equipment, I needed to upgrade from my flaky old analog scope to a digital storage scope or 'DSO'.

So I took a deep breath and invested in a shiny new 100MHz 2-channel DSO from Tektronix (the TDS320).

It cost around $4500 if I recall, which seemed like a massive sum; but it also seemed to offer pretty well all the features I'd need for some time to come.

And this indeed proved to be the case, as the trusty TDS320 served me faultlessly until a few weeks ago.

But then its traces flew out of sight, off the top of the screen and couldn't be persuaded to come back. The front panel board had developed a fault and I found that replacement boards were no longer available.

My only options were to send the scope back to Tek in the USA together with a cheque for US$1550 to cover a 'best efforts only' repair, or to use the TDS320 carcase as a trade-in on a new DSO.

Since sending the 7kg TDS320 back to Beaverton in Oregon would probably cost about $400-500 anyway, with no guarantee that they would fix it, the decision was easy – it was clearly time to upgrade to a new DSO.

So I began searching the web, to see what might now be available in my price range. And straight away I started to realise just how far DSOs had come since I had invested in the now-ancient TDS320.

Just about all of the latest models offered full colour LCD displays, for example, instead of the hefty 7" monochrome CRT monitor I had become used to.

This made them dramatically smaller and lighter in weight, while at the same time making the display much clearer and easier to analyse.

There had also been a significant increase in sampling rates and an even more dramatic increase in sample memory depth. Many of the latest models offered real-time sampling up to 1GS/s with a memory depth of well over 10KS (kilosamples) and in some cases up to 500KS or 1MS – a big advance on the 500MS/s sampling rate and modest 1KS memory depth per channel offered by my old DSO.

Most of the new models also offered a wider range of automatic measurement functions, including FFT frequency analysis, plus a more comprehensive range of triggering options. Just about all of them also offered the ability to save waveform screens and setups in either internal memory or a plug-in USB flash drive – or both.

Yet at the same time, the price tags on all of these latest models had dropped dramatically from the $4500 I had paid for the old TDS320. Some of the 2-channel 100MHz models were down to below $1000, in fact.

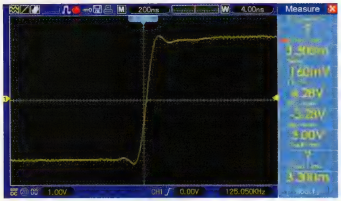
Digital storage 'scope technology has pushed ahead in leaps and bounds over the last few years. Each new model offers higher sampling rates, wider bandwidth, deeper sample memory plus a full colour display growing in both resolution and screen size – combined with shrinking physical size and a lower price tag than previous models.

Here's a look at the DST1102B from Chinese firm Tekway, showing just how far DSOs have come to date. It offers an impressive array of features, for a price that simply blows away most of the competition.

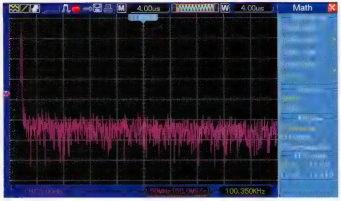
DESCREEN 100MHZ DSO

So I was faced with picking my way through a bewildering array of models offering all kinds of fancy bells and whistles, with prices ranging between about $1000 and $2500. If you've been looking for a new DSO you'll know exactly what I mean.

These two shots give a good idea of the width and depth (or more accurately, the lack thereof!) of the DST1102B. The rear panel is pretty spartan, with just the power input and that second USB port.



The leading edge of a 125kHz square wave from the Novatech scope calibration source, which has a very fast rise/fall time of 500ps (picoseconds). This shows the risetime of the DST1102B itself to be 3.300ns, which corresponds to a bandwidth of 106MHz – just over the rated 100MHz.



An FFT frequency domain display of a 100.350kHz sine-wave from a reasonably low distortion AF generator, with the fundamental peak visible at the left-hand end. All harmonics are at least 20dB below the fundamental up to above 23MHz.

Now I'll cut to the chase by telling you that after quite a bit of downloading and comparing specs, I finally settled on the new DST1102B scope made by Tekway Technologies in its factory in Hangzhou, China.

(As an aside, you won't be surprised to learn that most of the latest DSOs seem to be made in China.) Tekway scopes are distributed in Australia by Trio Smartcal, which you'll find at www.triosmartcal.com.au.

In a sense then, this review of the DST1102B is also an explanation of the rationale which led me to choose it over the other 2-channel 100MHz DSOs currently available. I'm being quite up-front about this, in the hope that my comments might help other people trying to pick the right brand and model for themselves.

The important features

OK then, away we go. The first thing that attracted me to the Tekway DST1102B was its widescreen hi-res colour display. The screen measures 177mm (7") diagonally, which is over 20% larger than the 145mm (5.7") screen found on most other models.

At the same time it has much higher resolution – 800 x 480 pixels, compared with the modest 340 x 240 pixel 'quarter VGA' resolution offered by most others (even those from the 'big names').

So the display is not only bigger and wider than most others, it's also much sharper and more detailed as well.

Of course there's much more to it than that. For example the sampling rate extends up to 1GS/s for real-time sampling and up to 25GS/s for equivalent time sampling – most impressive.

And the memory record depth extends up to a whopping 1MS for one channel, or 512KS per channel when both channels are being used.

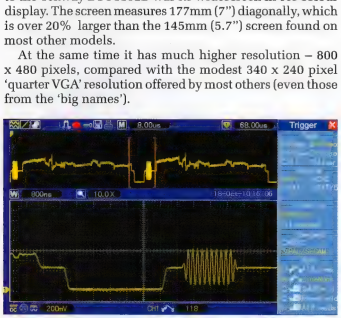
What's the advantage of this very deep sample memory? In a nutshell, it allows you to 'zoom in' to any particular point in a sample record and examine it in detail.

The DST1102B in fact provides a 'zoom' function which allows you to do just that, with the original waveform shown in the upper screen window and the zoomed-in area in the lower window. You can see this quite clearly in the screen grabs below.

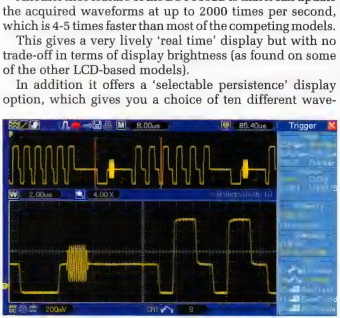
Another nice feature of the DST1102B is that it can update the acquired waveforms at up to 2000 times per second, which is 4-5 times faster than most of the competing models.

This gives a very lively 'real time' display but with no trade-off in terms of display brightness (as found on some of the other LCD-based models).

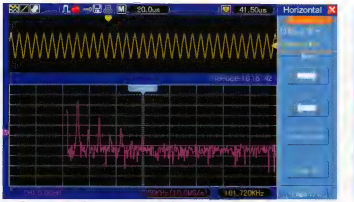
In addition it offers a 'selectable persistence' display option, which gives you a choice of ten different wave-



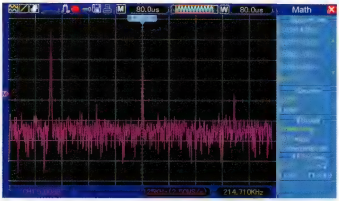
This next screen grab shows the DST1102B triggering on line 118 of the composite PAL video signal from a DVD player, with the basic two-line waveform shown at the top plus a zoomed-in view of the centre horizontal sync pulse and colour burst below. All details are clearly visible.



The same video signal but this time with the scope set to trigger on line 8 of the waveform – ie, in the vertical blanking interval (VBI). In the lower 'zoomed in' window is the first two of the six 'dancing pulses' added to lines in the VBI as part of the Macrovision copy protection system.



In the top window is a 101.720kHz triangular waveform signal from a function generator, plus an FFT of the same signal in the lower window. Note that as well as the 101kHz fundamental peak near the left-hand end of the display, both odd and even harmonics are visible up to the 7th.



Another FFT of the triangular wave signal from the same function generator, at a frequency of 214.710kHz, expanded horizontally to make the lower-order harmonics a little clearer. The 2nd harmonic is about 17dB down, the 3rd about 9.5dB down and the 5th harmonic about 15dB down.

form display durations: Automatic (ie, no persistence), 0.2s/0.4s/0.8s/1s/2s/4s/8s or infinite.

As well as the 'Auto Set' or automatic setup mode now found on most new DSOs, the DST1102B also offers an internal self-calibration mode which can be selected from its Utility menu at the touch of a button.

There's also a built-in real time clock and calendar, whose time and date are displayed on many of the measurement screens – and can be saved and exported in screen grabs, as you can see from at least one of the grabs shown here.

When it comes to acquisition modes and triggering options the DST1102B offers pretty well everything found on even the most expensive models.

For example it can acquire waveforms in one of four modes: real-time sampling, peak detect or averaging (with a choice of 4, 16, 64 or 128 waveforms), plus equivalent-time sampling. The acquisition memory depth can also be set to either 4KS, 16KS, 40KS or 512KS/1MS, as you wish.

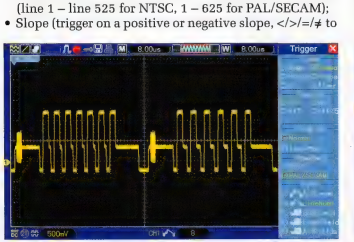
There are six selectable triggering modes, too:

- Edge (rising or falling);
- Pulse Width (20ns – 10s, with positive or negative width and also a choice of <, >, = or ≠ to a reference pulse width);
- Video (NTSC, PAL or SECAM, field select or line select (line 1 – line 525 for NTSC, 1 – 625 for PAL/SECAM);
- Slope (trigger on a positive or negative slope, </>/=/≠ to a set time span of 20ns-10s);
- Overtime (i.e., delayed triggering, where triggering is delayed by a nominated time duration from a positive or negative edge and the delay time can be set between 20ns and 10s); and
- Alternate, or Swap Trigger (where the scope triggers from each channel alternately, with a different triggering mode and/or sweep frequency for each).

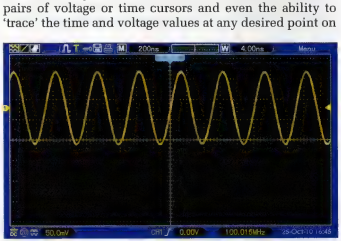
I should mention that the triggering system also provides a holdoff facility, where the scope can be prevented from triggering again for a nominated time after each triggering. This is great for capturing individual bytes or words in a serial stream. It also offers a choice of HF reject, LF reject and noise rejection filters, to optimise triggering reliability.

There's also an impressive range of automatic waveform measurements, any of which can be applied to either channel: frequency (6-digit resolution), period, arithmetic mean voltage, peak-to-peak voltage, cycle RMS, minimum, maximum, rise time, fall time, positive width and negative width. Up to eight of these measurements can be taken and displayed on-screen at any time.

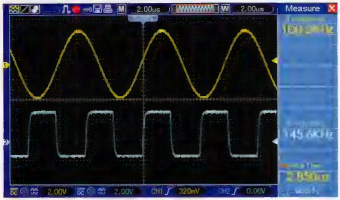
Quite apart from these 'automatic' measurements there's also the ability to make 'manual' measurements between pairs of voltage or time cursors and even the ability to 'trace' the time and voltage values at any desired point on



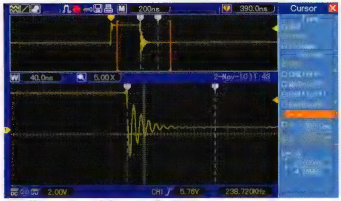
A composite PAL signal from a DVD player, showing the 'dancing' Macrovision pulses on lines 8 and 9 in the VBI. The pulses here are a little higher than those shown on the previous page and there are now seven pulses in line 8 but only six in line 9.



An unmodulated 100.016MHz sinewave from an RF signal generator illustrating the ability of the DSO to hide the measurement menu (right-hand side of the screen), so a waveform can be displayed over the full screen width. A single button press redisplays the menu at any time.



This shows one of the DST1102B's many clever triggering features: the ability to trigger alternately from the signals on channel 1 (a 100.0kHz signal [yellow]) and channel 2 (a 145.6kHz squarish wave [blue] from a different source). Both are rock steady, as a result of the alternate triggering.



An illustration of the way the DSO's measurement cursors can be used to make more specialised measurements. Here is the ringing after the trailing edge of 350ns-wide pulses, with the cursors used to show that the ringing lasts for around 210ns (delta T) and has a frequency of 4.76MHz.

a waveform using a single time cursor.

While we're talking about measurements and their display, it's worth noting that although the DST1102B displays many of the measurements in the 'menu' column at the right-hand side of the screen, this column can be 'hidden' at any time simply by pressing a front panel button.

This makes the full screen width available for examining the waveform(s), if you need it. Pressing the same button again restores the menu column and any measurements displayed on it.

Naturally, the DST1102B does provide the usual waveform 'math' functions: CH1 + CH2, CH1 - CH2, CH2 - CH1 and of course FFT (Fast Fourier Transform).

In the FFT mode there's a choice of Hanning, Flattop or Rectangular window functions, and there's also an FFT Zoom button to set the horizontal magnification in the FFT display window (x1, x2, x5 or x10).

Cursors can also be used to make two measurements within the FFT spectrum: amplitude in dB (relative to 1V) and frequency in Hz.

Two USB ports

Like many of the latest DSOs the DST1102B provides a 'Host' USB port on the front panel, so that waveforms and setups can be saved to a standard USB flash drive or 'thumb drive'. (The screen grabs shown in this review were exported this way.)

The same port can also be used to update the scope's internal firmware, using files downloaded from the Tekway website and copied over to a USB flash drive.

It's then simply a matter of plugging the flash drive into the front USB port, selecting the scope's 'Utility' menu and then pressing the 'Software Upgrade' and 'Confirm' (F6) buttons.

There's also a USB 'Device' port on the rear of the scope, to allow it to be hooked up to a PC directly using a standard USB A-B cable. Then by running matching software called 'TTScope' on the PC, display screens and setups can be transferred between the two in either direction, while the scope can even be 'driven' via a virtual front panel on the PC screen.

The TTScope software can be downloaded at no cost from the Tekway website (www.tekwayins.net), although when I tried doing this there still seemed to be a few minor bugs in the current version. Luckily these bugs were fixed soon after and I was able to get the scope and the PC "talking to each other" quite nicely.

Summarising

There are a few features of the DST1102B that I haven't mentioned as yet – like the inbuilt Help system, which provides context relevant on-screen help at any time simply by pressing the Help button. This largely makes it unnecessary to refer to the manual, which comes as a pdf file on a CD supplied with the scope.

The vertical and horizontal position controls also have a handy 'press to centre' option, while the horizontal time-base control has a similar function to allow adjustment of the horizontal zoom magnification.

Like most of the latest DSOs the DST1102B also provides a 1kHz squarewave signal output on the front panel (at lower right), to make it easy to adjust probe compensation. And the DST1102B comes with two high quality x10/x1 passive probes, with a bandwidth of 100MHz in the x10 switch position and 6MHz in the x1 position.

So that's the basic rundown regarding what you get with the Tekway DST1102B scope. As you can see from the main photo it comes in a sturdy case, with a built-in carrying handle and swing-down tilting feet.

The case measures only 313 x 142 x 108mm (W x H x D), and weighs in at a mere 2.08kg – less than one third the weight of my old TDS320.

As you can see then, the DST1102B compares very well indeed with virtually all of the latest-tech DSOs on the market, and blows many of them right out of the water. So what would you expect to pay for this compact high performance instrument?

I'll tell you: at the time of writing this review, Trio Smartcal have it available for $1495 plus GST. This is about half the price you'd expect to pay for a big brand model with comparable specs, so you can see why I decided to go with this one.

More info?

If you would like more information on the Tekway DST1102B, you'll find it on the Trio Smartcal website at www.triosmartcal.com.au. Or you can call them on 1300 853 407. SC

433MHz SNIFFER

by STAN SWAN

Here's a simple – and cheap – little 433MHz receiver that has many uses. It is ideal for checking that a suspect 433MHz "wireless" device (and there are scads of them) is actually working. It's great for finding out where interference is coming from. But most importantly (we believe!) it makes a great tracker for "fox hunts" and the like.

It's not widely appreciated that the popular UHF telemetry band – more correctly called the ISM (Industrial, Scientific and Medical) band, centred on 433.92MHz, actually covers a generous 1.7MHz between 433.05MHz and 434.79MHz.

It's probably just as well that more than one spot frequency is available, as an army of wireless door chimes, energy monitors, toys, car remotes, garage door openers, backyard weather stations and the like now festoon this licence-free spectrum slot.

Although such LIPD (Low Interference Potential Device) signals normally travel only a few hundred metres (as just a tiny 25mW transmitter power is permitted), its increasing popularity means that in urban areas a scanner tuned to the band may reveal a near-bewildering "African dawn chorus" of beeps, buzzes, pops, whirrs and scratches associated with nearby wireless data.

The ability to monitor local activity on this ever-more-crowded spectrum slice may ease device fault-finding or interference location, yet the cost and complexity of a UHF scanner may not be justified.

Hence it's with some satisfaction that we present a cheap (~$25), simple and sensitive "433" band monitor.

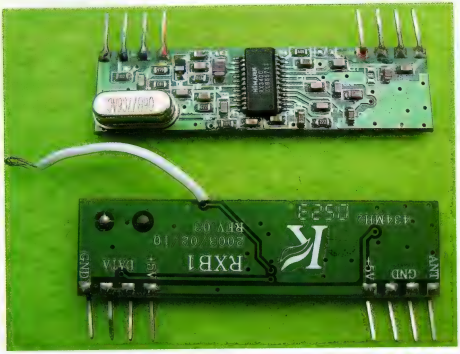
In an electronics age when almost anything seems possible, such receivers have not normally been available. With increasing band "noise", every "433" user should have one in his toolbox.

I've used mine extensively for wireless data monitoring and device activity checks and find it a near-indispensable "bang for buck" test item.

This recently again showed its worth, with a "no go" neighbour's 433.92MHz wireless door chime (an Arlec DC149). Although exceedingly efficient (two AA cells last around a year as the receiver spends most of its time on a ~200µA snooze), they use a super-regenerative receiver which, as with all regenerative types, radiates a small RF signal even while receiving.

It was the work of moments to bring the 433 monitor close to it and hear a suitable increase in background noise, ceasing when the receiver batteries were removed.

A computer-generated image (mostly created by Altium Designer) of the PC board version of our 433MHz Sniffer. This is the one to build if you want to make it a permanent project!



The heart of the project is this 433MHz ISM receiver module from Jaycar (cat ZW-3102). Both front and back are shown in the above picture. The wire connection is for the RSSI (strength indication), as explained in the text.

At the bell push itself, the outgoing transmitter data was readily heard but the fault turned out to be a weakening transmitter battery which as you would expect, reduced range.

And while we were sleuthing, a long misplaced (but still active) "CENTAMETER" mains energy sender was located in a backyard shed electronic junk box!

Design

Our monitor is based around Jaycar's widely available 433MHz receiver module (Cat ZW-3102). These reliable modules, sourced from Keymark/SpiritOn, sell for around $13 and find much use with 2400bps PICAXE wireless data.

But at around -105dBm they're nothing special sensitivity-wise. Although crammed with tiny SMD (Surface Mount Device) components, the modules are, at heart, just specialised ISM band receivers which only need a few connections to work – you don't have to do any assembly on the module.

Initially their biggest weakness appeared to be a need for 5V (±½V) supply. Initial thoughts were perhaps to use a 9V battery/7805 regulator, or maybe four "AA" cells and a series diode or two to drop the voltage to within range.

Although the module itself draws only draw a few milliamps, the 10mA or so drain from glowing LEDs and hissing speaker meant a costly 9V battery (of perhaps 200mAh capacity) would have soon been depleted.

However, it transpires the module's HiMARK RX3400 engine is happy with a supply as high as 7V, so even four fresh alkaline AAs (which can be ~1.6V each) would be quite OK, so no voltage regulation was eventually used. AA cells of course are universal, with even the cheapest far more "energetic" than a 9V battery.

Circuitry

Although considered digital data devices, acceptable audio (simply amplified by an NPN transistor) was indeed found available from the Jaycar module. However, don't expect orchestral quality!

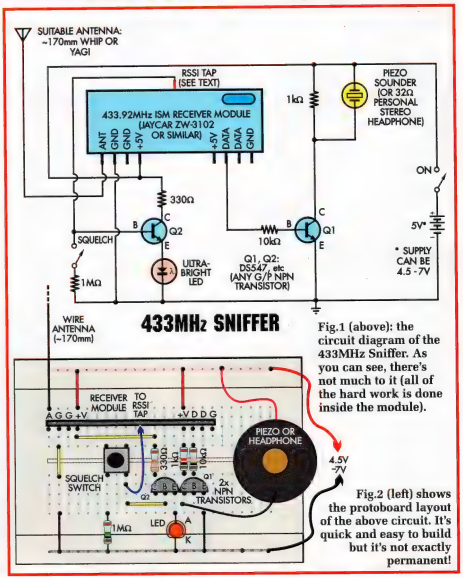
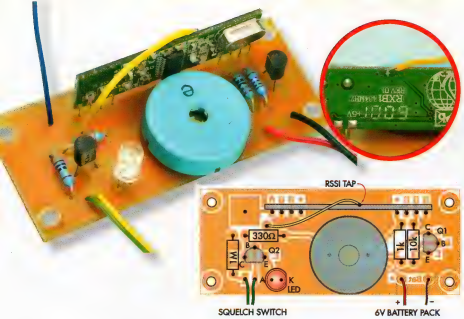


Fig.1 (above): the circuit diagram of the 433MHz Sniffer. As you can see, there's not much to it (all of the hard work is done inside the module).

Fig.2 (left) shows the protoboard layout of the above circuit. It's quick and easy to build but it's not exactly permanent!



(Left): the PC board version of the 433MHz Sniffer with the component overlay underneath. Inset is the connection to the RSSI terminal on the receiver PC board. While there is a tiny hole through the board, it's easiest to solder the tap as shown.

Parts List – 433MHz Sniffer

1 PC board, 70 x 28mm, code 06101111 **or**
1 small protoboard
1 433MHz ISM receiver (Jaycar ZW-3102)
2 NPN G/P transistors (eg, DS547)
1 ultrabright red LED
1 piezo sounder (NB: NOT a piezo buzzer)
1 4-way "AA" cell holder
1 SPST power switch (if required)
6 PC stakes
1 175mm length stiff copper wire (for antenna)
Hookup wire as required

Resistors (0.25W, 5%)

1 1MΩ (brown black green gold)
1 10kΩ (brown black orange gold)
1 1kΩ (brown black red gold)
1 330Ω (orange orange brown gold)

In the interests of prolonging battery life, a rugged, low-profile high-impedance piezo transducer was used. Although a high frequency responder, it gave very efficient sound generation at a good level.

Note this is NOT a piezo buzzer – they won't work at all!

A small low-impedance speaker (perhaps even one recycled from cheap 32Ω headphones) may also be considered but the output circuitry may need modification to suit and the current drain would no doubt be higher.

Squelch

For prolonged monitoring, receiver noise in the absence of signals may become annoying.

Although not essential, fitting a 3.9nF capacitor between the NPN base and ground was found to give hiss-free

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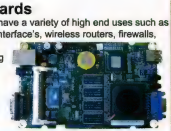

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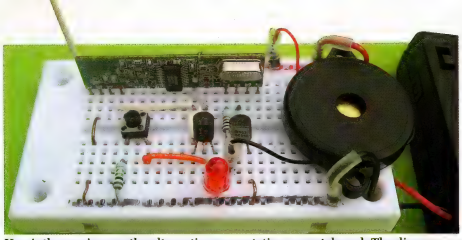


Here's the receiver on the alternative presentation, a protoboard. The diagram overleaf has a few minor differences (use the diagram when placing components to avoid any mistakes). The black object at right is a 4 x AA battery pack. No actual power switch is used – simply remove the batteries when not in use!

squelch, albeit at the cost of a slight decrease in sensitivity. If the second stage is attempted squelch can also be achieved with a 1MΩ resistor between the RSSI transistor base and ground.

RSSI activation

This one's for those with "macro" vision and a steady hand but it makes a very worthwhile "extra"!

An innovative circuitry feature, detected after data sheet scrutiny and very fine probing, relates to an undocumented RSSI (Received Signal Strength Indicator) tap on the Jaycar module.

RSSI is a measurement of the power present in a received radio signal, which the module (thanks to its HiMA-RK RX3400 "engine") offers as a small voltage swing at low current – even an ultra-bright red LED was only dimly lit.

A thin flying-wire feed at the tap point, taken to another NPN transistor and amplified gives an extremely useful LED brightness variation with signal strength.

The ZW-3102 RSSI tap point – although in the clear on the module (refer picture) – is very tiny and may be even covered by flux residues. Clearing it with a very fine needle or craft knife may first be needed.

Even when amplified, the brightness is still only modest, so select a modern, high efficiency red type – in my case, a discarded LED from a cheap 2009 Christmas decoration was found to be ideal!

Feeding the RSSI voltage into a PICAXE for READADC attention is tempting but the resulting increase in circuitry complexity and cost was not considered warranted at this stage. But being ever the optimist, some time in the future I *may* reconsider!

Presentation

We're showing this project in two forms. First is the way the circuit was originally developed, on a standard breadboard. All hobbyists should have one or more of these handy devices in their armoury simply because they can be used over and over again.

Circuit layout on the breadboard is not critical but the layout shown is easy and logical.

Although normally we'd be pretty wary of breadboarding a project at UHF, all the receiving work is being handled on the compact module. Only low frequency audio and LED feeds need be taken off this.

The second, more elegant method is on a specially-designed PC board, measuring 70 x 28mm and coded 06101111.

This is obviously a more permanent way to build the project and we would almost certainly mount it (and its piezo sounder) in a small box, complete with battery pack, on/off switch and squelch switch.

Assembly

It's recommend that assembly is done in two stages – in fact, the first (audio) part may be all many users will require. So first build the project with Q1 and its associated components (ignoring Q2, the LED, squelch switch etc) and confirm that it works as intended – that is, when you turn it on in the presence of any 433MHz signal you should hear an output from the piezo.

The second part, connecting the RSSI tap for LED brightness related to signal strength as detailed above, is extremely handy for RDF (Radio Direction Finding) but requires a fine wire connection to the module.

Which ever method you choose, simply follow the component overlay diagrams and you can't go wrong – that is, unless you put something in the wrong way around or in the wrong spot!

The receiver module, transistors, LED and of course power supply connections must all be correct or you could let the smoke out.

The entire monitor (PC board or breadboard version) can be powered by a 4 x AA battery pack and the setup could be housed in a cheap plastic box. If you use a clear plastic type, the RSSI LED will be visible through this and a few simple holes will accommodate a simple (RCA?) antenna socket or allow the piezo to be better heard.

A small, (cheap!) on/off switch and (if required) a similar switch for squelch can be mounted on the lid of the case.

Performance

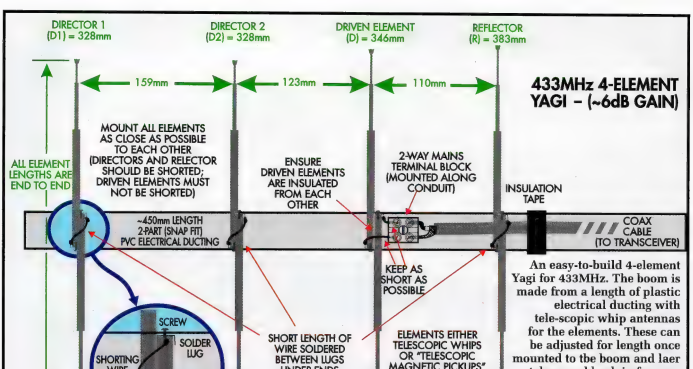
The circuit readily receives 433MHz transmissions (at unobstructed ranges) of several hundred metres using just a quarter-wavelength wire antenna (around 170mm). Even through vegetation and wooden buildings, reception ranges of 50-100m are typical.

A wireless doorbell sender makes a handy transmitter but first ensure it's not disturbing your neighbours! A PICAXE-08M driving of a matching Jaycar ZW-3100 433.92MHz transmitter can however easily be organised to send distinctive tones or a simple Morse beacon.

Attaching a directional antenna to the receiver will not only boost the range but also allow possible interference location and simple direction finding (DF).

Ah yes – direction finding. Wireless location, although perhaps at its peak locating the three "esses" (submarines, ships and spies) during WW2/Cold War, is still a VERY serious and fun pursuit. There's even whispers of it as a future Olympic sport (but don't hold your breath!).

Aside from locating emergency rescue beacons or tracking animals, an important RDF need relates to finding sources of radio and TV interference from bizarre electrical problems. These can sometimes be miles away and arise due to some really offbeat causes, such as a rubbing wire on a power pole, faulty power supply or suspect electric fence and so on.



An easy-to-build 4-element Yagi for 433MHz. The boom is made from a length of plastic electrical ducting with tele-scopic whip antennas for the elements. These can be adjusted for length once mounted to the boom and laer telescoped back in for easy storage. Alternatively, stiff wire (eg coathanger wire) could be used but mounting is more difficult.

As wavelengths at UHF are modest (being ~70cm at 433 MHz), antennas can be quite compact and mildly directional. A major UHF RDF (Radio Direction Finding) issue however relates to the terrain and nearby reflective surfaces (especially metallic), which may cause signals to apparently come from unexpected directions. Serious searchers prefer sophisticated Doppler RDF gear but a lot of fun is possible in open spaces with simple receivers and plain body shielding or a simple directional antenna

The antenna

The modules are sensitive enough "as is" to detect even weak nearby signals but normally a quarter-wavelength vertical whip will be needed. At 433MHz wavelengths (~690mm), just a 170mm whip made from a piece of stiff wire does well. Radio waves in fact slow down slightly in conductors, meaning the normal wavelength (and therefore antenna length) will be slightly shorter than 690mm.

While the length won't be too critical, the RSSI LED may even help you cut the antenna to the right length – start somewhat longer and trim the wire to suit for maximum brightness when the receiver is receiving!

Note: for eye safety ensure the top of this whip is capped, folded over and/or marked with a simple tape "flag" – it can be hard to see such slender wires when working close to a circuit board! It's even harder to spot at night or when tracking something through the bush.

Although simple whips have omnidirectional coverage, a technique of "body shielding" can allow the transmitter direction to be broadly estimated.

This exploits the RF shielding of your own body – just hold the receiver close to your chest while slowly rotating yourself.

At some point, (ie, when the transmitter is behind you), the received signal will significantly decrease. Repeating the technique nearby should then allow triangulation clues on the transmitter location.

A better antenna

For serious work however, a directional antenna will be needed. There are numerous designs available with the classic Yagi arguably being the most popular (Google 433MHz Yagi and you'll find *quite* a few!).

Making one's own antenna further also demonstrates resonance and wavelength/frequency relationships.

At 433MHz a half wavelength is only a few hand spans, so quite a compact classic Yagi beam can readily be rustled up using stiff wire mounted on a broom handle or plastic rod. Shielded TV grade coaxial wire can be run to the module, or even the entire receiver mounted on the antenna itself.

Compared with an omnidirected whip, even a 4-element version will give some 6dB gain – equivalent to doubling the range.

Perhaps more useful is that the enhanced front-to-back pickup ratio improves direction finding. A large part of the RDF fun relates to disguising the transmitter as a plant, or everyday item such as sunglasses, candy bars or clothing etc! See http://members.aol.com/homingin/ or Google it.

Well, there you have it. Not only a useful RF test item but also a handy RDF "engine" suiting outdoor use (once encased).

Youngsters, such as scout groups, can run off excess energy "fox hunting" hidden 433MHz transmitters while triangulating signals or mastering map reading. A parent's dream!

Resources and references

For convenience these are hosted at www.picaxe.orcon.net.nz/433RX.htm SC

By ROBERT SCOTT

Cranial Electrical Stimulation Unit

Commercial cranial electrical stimulation (CES) units cost hundreds of dollars but this one is cheap and easy to build. It is battery-powered, portable and has adjustable current delivery and repetition rate.

NO, THIS IS NOT a do-it-yourself electroshock therapy project. The voltage and current used for Cranial Electrical Stimulation (also known as Transcranial Electrotherapy or Neuroelectric Therapy) is very low, ensuring that it is safe for the recipient. It does not cause a "shock" sensation or a lot of pain, although it can result in "pinpricks" at the higher settings.

However, at the voltage and current levels involved with this project there is no risk of injury.

We are not doctors so we can not say whether CES is beneficial. Some claim that it reduces anxiety, treats pain (especially headaches) and promotes alertness and relaxation. If you have investigated the potential benefits and would like to try CES, building this project is a cheap and easy way to do so.

We can't rule out the possibility that the benefits from CES are a placebo effect but if true, such benefits are still real. If so, it would be a case of "mind over matter!"

What is CES?

CES involves passing a small amount of current through the recipient's head. A proportion of this is thought to pass through the brain and create chemical changes which may influence mood.

Obviously we must be careful to limit the amount of power that can pass through a sensitive organ like the brain. In this case, the current is limited to a maximum of half a milliamp (0.5mA) and the voltage is limited to 15V. Since the unit is powered from a small battery (four AAAs) rather than mains, there is no possibility that a fault could result in a fried noggin!

Commercial CES devices vary but generally deliver somewhere between 0.01mA to 1mA with a repetition rate between 0.5Hz and 100Hz. With this unit, both parameters can be adjusted, so you can find the combination that works best for you.

The Transcutaneous Electrical Nerve Stimulation or TENS unit published in SILICON CHIP, January 2006 is similar in some respects. That unit also relied on electrical stimulation of the human body but at higher voltage and current levels. However, as stated in the TENS article, these levels are unsuitable for use on the head or neck, so this CES unit has been designed to deliver much less power in order to make it safe.

Current is delivered to the patient via clip-on leads that attach to the

The Cranial Electro-Stimulator is built into a low-profile instrument case and is powered by four AAA 1.5V cells.

ear lobes. While at first it may seem unlikely that just 15V can result in current conduction through the human body, the ear tingling and (at higher settings) pin-prick sensation demonstrates that a circuit is indeed made. Just how much current is flowing is indicated by the brightness of two LEDs on the front panel.

For further evidence that a voltage this low can cause current to flow through the human body, set a DMM to Ohms mode and hold a probe in each hand. This will show your own body's resistance, which varies depending on the amount of moisture on your hands. You should find that holding the probes behind your ears results in a similar reading. Generally you will find it is below 1MΩ.

Circuit description

Take a look now at Fig.1 for the circuit details. It's based on four CMOS digital logic ICs and a handful of other parts. The ICs are readily available and since the circuit is based entirely on discrete logic, there is no need for a microcontroller.

IC3 and IC4 form the on/off switch logic and session timer. They also flash the "RATE" LED at 1Hz to indicate that the unit is operating. IC3 is a 4011 quad 2-input NAND gate and IC4 is a 4040 12-stage binary counter.

IC3a and IC3b together make an RS flip-flop. Pin 1 is its Reset input and pin 6 is its Set input. When pin 1 is pulled low (ie, button S1 is pressed), the output at pin 4 goes low and when pin 6 is pulled low (ie, button S2 is pressed) it goes high.

When the ON button (S1) is pressed, the output of the flipflop goes low and this turns PNP transistor Q1 on. As long as Q1 remains on, power from the battery can flow to the rest of the circuit. Pressing S1 also resets IC4 (via IC3d), starting the session timer.

The 10kΩ pull-up resistor and 100nF capacitor across S1 form a filter which debounces the button press and also ensures that the device is off initially when the batteries are installed. Note that IC3 is permanently connected to the battery but since it draws well under 1μA, its current draw is less than the cells' self-discharge current.

IC4's clock input (pin 10) is driven at 2Hz (by pin 3 of IC1) so after 25 minutes of operation, outputs O10 and O11 (pins 15 & 1) of timer IC4 both go high. As a result, IC3c's output goes low, pulling down pin 6 of IC3b which has the same effect as pressing

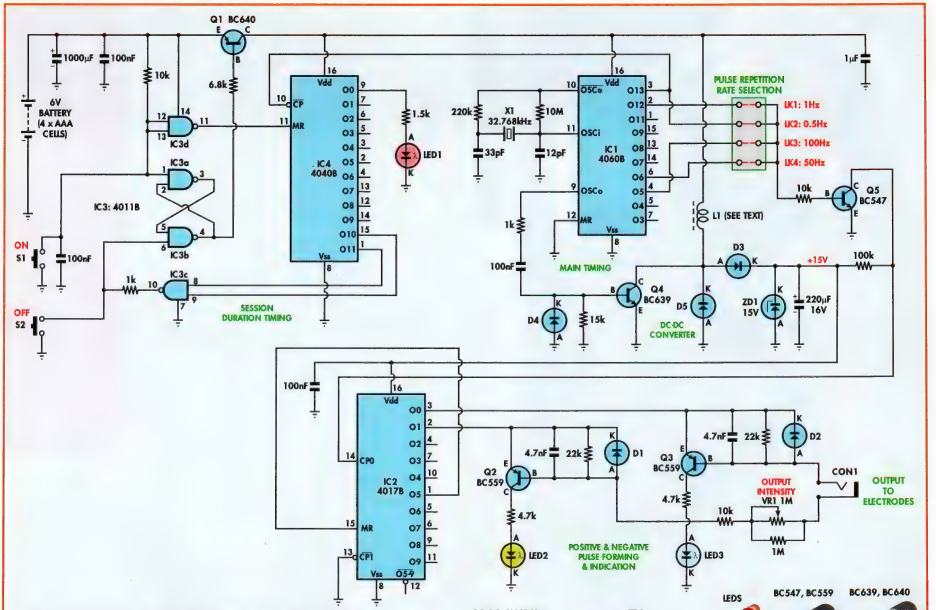
Main Features

- Adjustable current (0.03-0.5mA)
- Adjustable repetition rate (0.5-100Hz in four steps)
- Battery powered
- Portable
- Flashing activity LED
- Automatic turn-off timer (25 minutes) which can be reset
- LEDs indicate intensity of stimulation
- Long battery life (up to 100 hours continuous operation)

Warning!

(1) This unit (or any other similar device) must not be used on a person who has a Heart Pacemaker or other implanted electronic device.

(2) Do not be tempted to run this unit from a mains adaptor, plugpack or power supply. This could be dangerous if a breakdown occurs in the isolating transformer.



CRANIAL ELECTRO-STIMULATION UNIT

Fig.1: the circuit is based on four low-cost CMOS ICs. Quad NAND gate IC3 and 12-stage binary counter IC4 form the on/off switch and session timer, while 14-stage binary counter IC1 and decade counter IC2 set the pulse repetition rate. IC1 also forms a crystal oscillator (in conjunction with X1) and drives a boost converter based on Q4, inductor L1 and their associated diodes to produce a +15V rail.

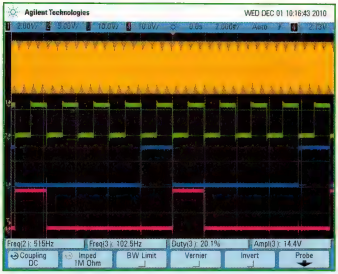


Fig.2: the yellow trace shows the 32.768kHz waveform from the crystal oscillator at pin 10 of IC1. Below it, the green trace is the 512Hz signal at pin 4. The two lower traces show the alternating output pulse at pins 2 and 3 of IC2. As can be seen from the measurements, the output frequency is 102.5Hz (nominally 100Hz) and the duty cycle is 20%.

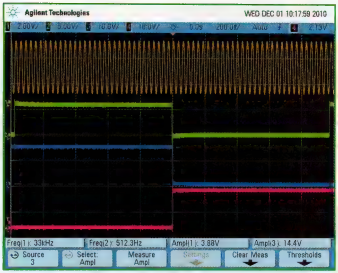


Fig.3: these are the same signals as shown in Fig.2 but with a shorter timebase so that the 32.768kHz sinewave-like oscillation of the crystal is visible. As can be seen, when the first output pulse ceases the second immediately begins, causing a voltage differential across the electrodes. The output amplitude, as shown, is just below 15V

the OFF button (S2). As a result, the RS flipflop is set and so Q1 turns off, powering down the circuit.

Pulse timing

Pin 9 of IC4 (O0) is the lowest timer output bit and this toggles at half the input clock rate, flashing high-brightness red LED1 at 1Hz while ever IC1 is powered. The 2Hz source clock is produced by IC1, a 4060 14-stage binary counter. Pins 10 and 11 of IC1 form a crystal oscillator circuit based on X1, a 32.768kHz watch crystal.

Now 32,768 is 2^{15}, so a binary counter can derive exact 1Hz pulses from this frequency by dividing it in half 15 times. Since IC1 is a 14-stage ripple counter, it produces a 2Hz output at O13 as well as 4Hz at O12, 8Hz at O11 etc.

Depending on which of LK1-4 is shorted, one of IC1's clock outputs drives the base of Q5, an NPN transistor which acts as a level shifter. This allows IC1 – which runs from a 6V (nominal) battery – to interface with IC2 which runs off a higher voltage (15V). When Q5 is off, a 100kΩ resistor pulls pin 14 (CP0) of IC2 high to 15V. Conversely, when Q5 is on, that pin is pulled low to 0V.

CP0 is the clock input of IC2, another counter IC. This one is configured to divide its input frequency by five, since its sixth output (O5) is connected to its reset pin (pin 15). Depending on which of LK1-4 is installed, IC2 is driven at 4Hz, 2Hz, 512Hz and 256Hz respectively.

After being divided by five the result is 0.8Hz, 0.4Hz, 102.4Hz and 51.2Hz. These are the four pulse repetition rate options available, which we round to 1Hz, 0.5Hz, 100Hz and 50Hz for convenience.

Voltage booster

IC1 does double duty by also driving a boost converter based on transistor Q4. Its pin 9 output (which is an inverted version of the clock signal on pin 10) drives Q4's base. This works with inductor L1, diodes D3-D5 and zener diode ZD1 to generate a nominal 15V rail which powers IC2 and ultimately provides the cranial stimulation.

In operation, the 32.768kHz square wave from pin 9 of IC1 is AC-coupled to the base of Q4, an NPN transistor with a 1A rating. When the output from pin 9 is high, Q4's base-emitter junction is forward biased and so it "sinks" current from the battery through L1, a high-value inductor. This charges its magnetic field.

When the output from pin 9 subsequently goes low and Q4 switches off, the collapsing magnetic field causes a voltage spike. This in turn forward biases D3 and charges the 220μF capacitor at its output. The voltage across this capacitor is limited to 15V by ZD1.

D4 protects Q4's base-emitter junction from being reverse biased, while the 15kΩ resistor provides DC bias and ensures a fast switch-off. The 1kΩ series resistor limits the base current.

The advantage of using a boosted supply rather than just more battery cells is reduced size and weight as well as a consistent voltage for cranial stimulation, even as the battery discharges and its voltage drops.

Electrode drive

As mentioned, IC2 divides its input clock by five. This means each of its O0-O4 output pins is high for 20% of the time and low the remaining 80% of the time. Two of these outputs (O0 and O1) drive the cranial electrodes while the other three are not connected. As a result, the electrodes are driven alternately, followed by a pause.

Current for the electrodes flows from O0, through the recipient's head and back to O1, or it flows the other way around. When one of these outputs is sourcing current, it passes through a 22kΩ resistor which provides current limiting. Alternatively when sinking current, most of the current flows through either diode D1 or D2.

High-brightness LEDs

Transistors Q2 & Q3 drive high-brightness blue and green LEDs to indicate which output is sourcing current and how much is flowing. The more current that passes through one of the 22kΩ resistors, the higher the base-emitter voltage of the associated transistor.

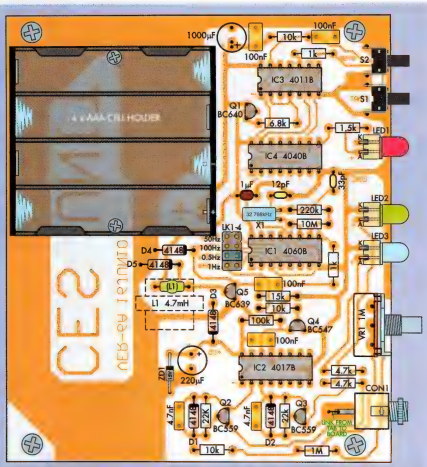


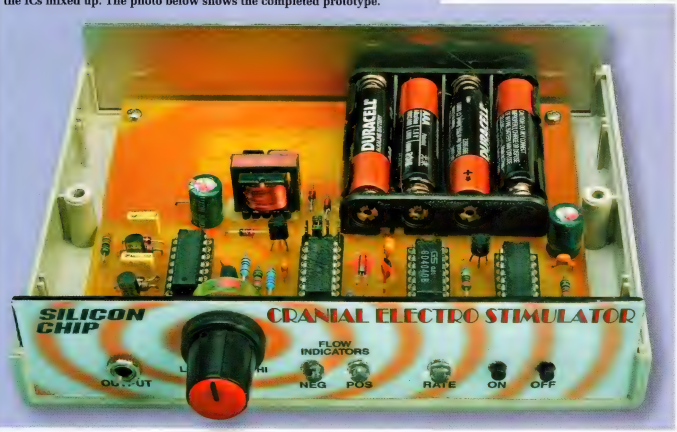
Fig.4: follow this layout diagram to assemble the PC board. Make sure that all polarised parts are correctly orientated and be careful also not the get the ICs mixed up. The photo below shows the completed prototype.

These transistors drive high-brightness LEDs. Higher base-emitter voltages result in more current flow to these LEDs and thus they glow brighter. A 4.7nF capacitor across each base-emitter junction prevents AC signals coupled via stray capacitance (primarily within Q2 and Q3) from turning on the LEDs when there is no electrode current.

Note that there is additional resistance between output O1 and the electrodes, as compared to the path from O0. This consists of a series 10kΩ resistor and 1MΩ potentiometer (VR1), with a 1MΩ fixed resistor in parallel with the latter. The 10kΩ resistor provides additional current limiting while VR1 allows the stimulation current to be adjusted from approximately 0.03mA to 0.5mA.

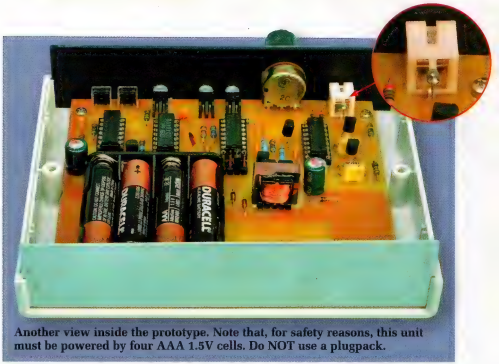
Inductor selection

The inductor (L1) used in the prototype was obtained from a non-functioning compact fluorescent lamp (CFL). If you have a faulty 15-20W CFL, you can open it up by clamping the base in a vice and then cutting through the groove in the plastic base using a hacksaw. Chances are it will contain a suitable choke. Be careful not to break the glass tube(s) during this operation.



If you do not have an unserviceable CFL to dismantle, a 4.7mH (or thereabouts) inductor with a current capability of at least 100mA can be substituted. These are available from Altronics (Cat. L7054). Alternatively, if you have an inductance meter, you can wind your own inductor on a ferrite or powdered-iron core – just add turns until the measured inductance is in the appropriate range.

The salvaged inductor in the prototype measured 7mH. The lower the inductance value used, the higher the battery drain when the unit is operating, as the peak current through L1 is higher. A 4.7mH inductor increases the battery current by around 2mA compared to using a 7mH inductor. For this reason, we do not recommend going much lower than 4.7mH.



Another view inside the prototype. Note that, for safety reasons, this unit must be powered by four AAA 1.5V cells. Do NOT use a plugpack.

Construction

All the parts are mounted on a single-sided PC board coded 99101111 and measuring 118 x 102mm. Fig.4 shows the assembly details.

Begin by checking the board for any defects, then fit the resistors. Use a digital multimeter (DMM) to check the value of each resistor before installing it. Once they are in, follow with the diodes (D1-D5) and zener diode (ZD1). Ensure that the striped end of each diode is orientated as shown on Fig.4.

Follow with the ICs, taking care to ensure that each is correctly orientated and that it is installed in the correct location. Alternatively, if you are using sockets (optional) then install them instead. In either case, the notch or dot that indicates pin 1 goes towards the back edge of the board.

Check also that each device is sitting flat on the PC board before soldering its pins. Do not get the ICs mixed up, as they are all different types.

Crystal X1 is next on the list. It doesn't matter which way around it goes. Lay its body flat against the PC board using a small piece of double-sided tape to hold it in place, to avoid stress on the leads.

Next mount the five transistors (Q1-Q5). There are four different types so check the marking on each before installing it, to ensure it goes in the right place. Use small pliers to bend the legs outwards at 45° and then back down parallel again so that they fit in the holes on the board. Be sure to orientate each one as shown on the overlay.

Now solder the MKT and ceramic capacitors in place, followed by the pin header strip and the two electrolytic capacitors. The electrolytics must be correctly orientated, so be sure to match their positive (longer) leads with the "+" signs on the overlay.

Follow with the two tactile switches, which must be pushed flat against the PC board before being soldered.

The 3.5mm jack socket is not a PC-mount component so this must be modified before it is installed. First, use pliers to pinch the eyelet holes shut, except for the longer one projecting from the rear of the connector. That done, bend the shorter lead at the rear down at right angles (see photo).

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
1µF	1µF	1u0	105
100nF	0.1µF	100n	104
4.7nF	.0047µF	4n7	472
33pF	NA	33p	33
12pF	NA	12p	12

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	10MΩ	brown black blue brown	brown black black green brown
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	22kΩ	red red orange brown	red red black red brown
❑	1	15kΩ	brown green orange brown	brown green black red brown
❑	3	10kΩ	brown black orange brown	brown black black red brown
❑	1	6.8kΩ	blue grey red brown	blue grey black brown brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	1.5kΩ	brown green red brown	brown green black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown

Parts List For Cranial Electro-Stimulator

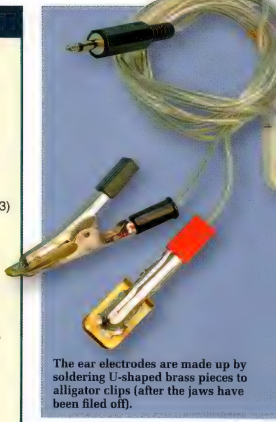
1 PC board, code 99101111, 118 x 102mm
1 ABS instrument case, 140 x 110 x 35mm (Jaycar HB-5970)
1 PC-mount 4 x AAA battery holder (Jaycar PH-9270)
2 right-angle tactile switches (Jaycar SP-0607)
1 3.5mm mono phono jack socket (Jaycar PS-0122)
1 3.5mm mono phono jack plug (Jaycar PS-0114)
1 knob to suit VR1
1 4700µH inductor (Altronics L7054) or higher value choke salvaged from a CFL (L1)
1 32.768kHz watch crystal (X1)
1 2 x 4-pin header, 2.54mm pitch
3 16-pin DIL sockets (optional)
1 14-pin DIL socket (optional)
1 jumper link for pin header
1 pair 65mm alligator clips
3 right-angle LED mounting blocks (Jaycar HP-1114, packet of 20)
4 No.4 x 6mm self-tapping screws
double-sided tape
100 x 12 x 0.127mm (0.005-inch) brass sheet
1 2m-length twin core cable
25mm 0.71mm diameter tinned copper wire
25mm heatshrink tubing, 5mm diameter
1 front panel label
1 1MΩ 16mm linear potentiometer (VR1)
2 M2 x 5mm machine screws & nuts

Semiconductors
1 CD4060/HEF4060 14-stage ripple counter (IC1)
1 CD4017/HEF4017 decade counter/divider (IC2)
1 CD4011/HEF4011 quad 2-input NAND gate (IC3)
1 CD4040/HEF4040 12-stage ripple counter (IC4)
1 BC640 PNP transistor (Q1)
2 BC559 PNP transistors (Q2, Q3)
1 BC639 NPN transistor (Q4)
1 BC547 NPN transistors (Q5)
5 1N4148 signal diodes (D1-D5)
1 15V Zener diode (ZD1)
1 5mm high-brightness red LED (LED1, Jaycar ZD-0283)
1 5mm high-brightness green LED (LED2, Jaycar ZD-0176)
1 5mm high-brightness blue LED (LED3, Jaycar ZD-0281)

Capacitors
1 1000µF 10V electrolytic
1 220µF 16V low-ESR electrolytic
1 1µF monolithic ceramic
4 100nF MKT
2 4.7nF MKT
1 33pF ceramic
1 12pF ceramic

Resistors (0.25W 1%)

1 10MΩ	3 10kΩ
1 1MΩ	1 6.8kΩ
1 220kΩ	2 4.7kΩ
1 100kΩ	1 1.5kΩ
2 22kΩ	2 1kΩ
1 15kΩ	



The ear electrodes are made up by soldering U-shaped brass pieces to alligator clips (after the jaws have been filed off).

Next, solder a piece of tinned copper wire to the remaining eyelet, making sure it is long enough to go through the PC board. That done, push the two leads through the board and solder the connector in place.

The LEDs go in next. Their leads must be bent down at right-angles 5mm from the lens but first check the orientation. In each case, the longer lead goes through the hole marked "A" (anode) on the overlay. Once the leads have been bent, insert each through a plastic mounting block and attach this to the PC board using double-sided tape. Once they are in place, solder and trim the leads.

Inductor L1 can go in next, then using a hacksaw, trim VR1's shaft to 9mm (as measured from the end of its mounting thread). File off any burrs before mounting it on the PC board.

Finally, attach the battery holder to the board using M2 machine screws and nuts. Alternatively, if these are not available, it can be held down using double-sided tape. Once it is firmly attached, solder its pins.

Making the electrodes

The electrodes are made from a 100 x 12mm brass sheet and some alligator clips.

First, cut the brass sheet into two 50 x 12mm strips, then bend each strip into a "U" shape using a thin piece of scrap wood fixed in a vice. That done, file the teeth off the alligator clip jaws and burnish the inner faces and edges with emery cloth. The U-shaped brass pieces can then be inserted into the jaws of the alligator clips and soldered in place (see photo).

Next, trim and file away any excess at the edges, then use the emery cloth

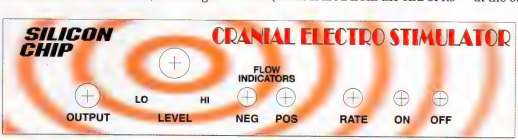


Fig.5: this full-size artwork can be copied and used as a drilling template for the front panel. It can also be downloaded in PDF format from the SILICON CHIP website.

The electrodes plug into the output socket on the front panel. Also on the front panel are the on-off buttons, the current-flow indicator LEDs and the level control.

to remove any sharp jags. Make sure the clips have no sharp protrusions then test them on your earlobes. If they are too tight, the tension can be adjusted by bending the spring.

Once the clips are ready, solder them to one end of a 2m-long figure-8 cable, spreading it into a "Y" shape about 30cm from the end. That done, slide heatshrink tubing over the split and shrink it down, to prevent the cable from pulling apart further. Solder the wires at the other end of the cable to the two tabs of a 3.5mm mono phono jack plug.

Alternatively, rather than making your own electrodes, you may be able to make use of ECG or TENS electrodes which can be bought from some pharmacies.

Testing the board

If you have a bench supply, set it to 6V with a current limit of approximately 20mA. Otherwise, use the four cells to power it for testing.

If possible, it is a good idea to insert a DMM in series with the supply to check the current flow. Initially, leave the ICs out of their sockets (assuming they are not soldered to the board). Also check that the board is resting on a non-conductive surface.

When the supply is connected, the current should be practically zero. If so, switch off and insert the ICs, then switch it back on. With the ICs in place, the current drain should be around 0.03µA. However, this is below the measurement range of most DMMs so they will read zero. If the current is significantly above the expected level, disconnect the supply and check for assembly errors.

Now press the "ON" button and watch the current reading. It should increase to around 8-10mA and the RATE LED should flash. When the RATE LED is on, the current reading will be slightly higher. Use a voltmeter to check the voltage between pins 16 & 8 of IC2 – it should be around 15V.

If that checks out, turn VR1 fully anti-clockwise, plug in the electrodes and install the shorting block on LK1. Now temporarily connect the electrodes together (ie, create a short circuit) and slowly turn VR1 clockwise. LED2 and LED3 should now begin to flash alternately at 1Hz, getting brighter as VR1 is turned up.

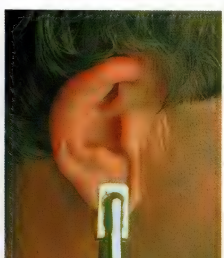
Finishing up

Assuming it all works correctly, the board can now be installed in the case.

First, use Fig.5 as a drilling template for the front panel. Start each hole using a pilot drill, then enlarge it to the correct size using larger drill bits or a tapered reamer, to ensure they stay round. Once the holes are made, check that they line up properly with the PC board.

The front-panel label can now be prepared. You can either copy Fig.5 or download a front panel label in PDF format from the SILICON CHIP website. Once it is printed, laminate it and cut out the necessary holes, then attach it to the front panel using a thin smear of silicone sealant or spray adhesive.

Leave the sealant to cure overnight before attaching the PC board assembly. It's just a matter of feeding the board components through their corresponding front panel holes, then securing the panel by fitting the nuts to the output socket and potentiometer. The knob can then be fitted to the pot shaft.



The U-shaped brass pieces ensure operator comfort when the electrodes are attached to the ear lobes

Before the board can be lowered into the case, two plastic standoffs at the front of the case (towards the centre) must be removed. These can be filed away or cut off with large side-cutters. The board assembly can then be lowered into the case and secured in place using four self-tapping screws.

Finally, install the jumper link on LK1-4, depending upon the repetition rate you want to use, and attach the lid. If you are not sure, start with 0.5Hz; you can always remove the lid later to try the other settings.

Using it

Before using it, turn VR1 fully anti-clockwise. Attach the electrodes to the recipient (or yourself) and press the ON button. The RATE LED will flash at 1Hz to confirm that the device is operating.

Now slowly turn up VR1. When the green and blue LEDs barely light, this indicates that around 25µA is flowing through the electrodes (and thus the recipient). At full power, around 500µA can flow and the LEDs will light brightly. As previously stated, the two LEDs indicate the current flow in each direction.

We recommend the use of alkaline cells for this project as they last well in devices which draw a small amount of current over a long period and also have a good shelf life.

That's it. We hope that you find this project sufficiently stimulating (groan!). SC

By MAURO GRASSI

Universal USB Data Logger: Pt.2

Last month, we described the main features of the USB Data Logger and gave the circuit details. This month, we give the assembly procedure, explain how to install the Windows driver and PC host software and describe how the unit is used.

AS MENTIONED last month, a major feature of the USB Data Logger is its custom scripting language. This makes it very versatile and allows it to be interfaced to many different sensor types. It can be interfaced to most digital sensors, almost all I²C and 1-wire sensors, and almost any analog sensor, frequency input or counter.

Custom scripting also makes it highly configurable. If you have a logging application in mind, this unit will almost certainly be suitable.

The accompanying PC software is used to compile the custom "scripts". These provide the instructions for reading the various sensors and for processing the data. So this unit can not only log data but can also analyse that data!

Towards the end of this article, we run through a number of scenarios and give some example custom scripts. These are a good starting point for learning to write scripts for your own logging applications.

What it can do

Before moving on to the construction, let's run through a few things the USB Data Logger can do.

First, if you have a weather station, you can log a whole day's worth of temperatures and then compute the average. You could also extract the daily maximum and minimum temperatures and log them as well.

Second, if you have a number of digital sensors connected to the I²C bus, you can send commands to read from them, log their values or send commands to power them down during extended periods when no logging needs to occur. Note that the USB Data Logger itself will automatically switch into standby mode during extended periods of inactivity to save power.

You can also read from a sensor and execute code depending on the reading reported by the sensor. For example, if you have a temperature sensor, you can monitor its value and turn an external relay on or off (eg, to control an air-conditioner) if the value is outside a specific range.

These are just some examples of what is possible.

If you've ever programmed before, it should be very easy to understand and write programs for the USB Data

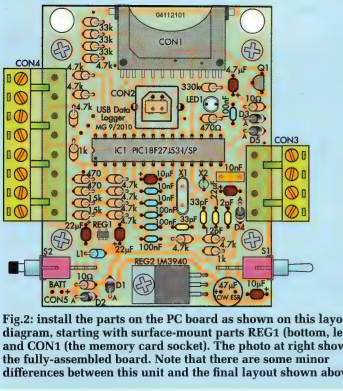


Fig.2: install the parts on the PC board as shown on this layout diagram, starting with surface-mount parts REG1 (bottom, left) and CON1 (the memory card socket). The photo at right shows the fully-assembled board. Note that there are some minor differences between this unit and the final layout shown above.

Logger (the scripting language's syntax is simple and loosely based on C). If not, we give a very quick introduction at the end of this article, with a number of examples showing code that can be used.

It shouldn't take too long to learn and a full description of the language can be downloaded as a PDF file from the January 2011 section of the Silicon Chip website – www.siliconchip.com.au

Board assembly

The Universal USB Data Logger is built on a double-sided PC board coded 04112101 and measuring 60 x 78 mm. This is housed in a plastic instrument case measuring 68 x 130 x 25mm (W x D x H).

Fig.2 shows the PC board assembly details. It should take no more than a couple of hours to assemble but before starting, check it carefully for hairline cracks in the copper pattern and for shorts between tracks and pads.

Once you are satisfied that everything is OK, start the assembly by soldering in the SMT (Surface Mount Technology) boost regulator (REG1). This is a a TPS61097-33DBVT device in a SOT23 5-pin package and is mounted on top of the board, towards the bottom left corner. You will need a fine-tipped soldering iron and a steady hand to solder it in.

A magnifying lamp will also be useful, if you have one.

The best way to install REG1 is to first position it over its pads (it can only go one way) and then hold it in position using some sticky tape, leaving pin 5 uncovered (see Fig.1 in Pt.1). That done, heat the pin and apply the solder quickly, taking care not to apply the heat for more than a few seconds. The solder should melt easily and secure the pin and pad.

Let it cool, then solder pin 3, which is diagonally opposite. Once that is done, you can remove the sticky tape and solder the remaining three pins. If any solder bridges form, use solder

Table 4: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
10nF	0.01µF	10n	103
33pF	NA	33p	33
12pF	NA	12p	12

Table 3: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	330kΩ	orange orange yellow brown	orange orange black orange brown
❑	3	33kΩ	orange orange orange brown	orange orange black red brown
❑	2	15kΩ	brown green orange brown	brown green black red brown
❑	10	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	3	470Ω	yellow violet brown brown	yellow violet black black brown
❑	2	10Ω	brown black black brown	brown black black gold brown

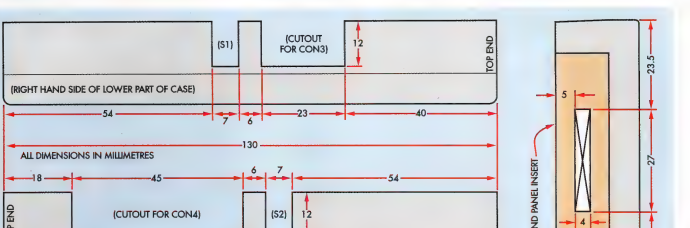


Fig.3: follow this diagram to make the cutouts in the base of the case. The side cutouts provide clearance for switches S1 & S2 and the two screw terminal blocks, while the end cutout provides access to the memory card socket.

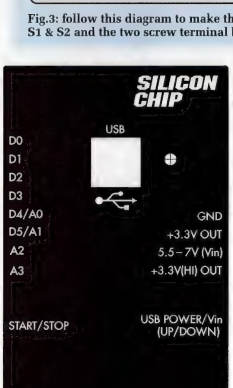


Fig.4: this front-panel artwork can be used as a template for cutting out the access hole for the USB socket and drilling a hole for the 3mm blue LED.

wick (or desoldering braid) to remove them.

The memory card socket is next on the list and this is also soldered to the top of the board. It has two small plastic locating posts that fit into matching holes in the PC board. These correctly place it in position over its pads.

Solder the two holding pads on its sides first to secure it in place. Once that is done, solder the rest of the pins but be careful not to apply heat to the plastic body, as it will melt. As before, use solder wick if you accidentally create solder bridges between adjacent pins.

Now for the resistors. Table 3 shows the resistor colour codes but you should also check each one using a DMM before installing it on the board, just to make sure. Note that, due to space restrictions, the resistors are all mounted vertically (see photos and Fig.2).

The five Schottky diodes can go in next. Unlike the resistors, these need to be orientated correctly. Their cathodes are indicated by a grey stripe at one end, while each anode connection is indicated with an "A" on the screened overlay.

The TO-220 regulator (REG2) mounts horizontally on the PC board. To do this, first bend its leads down through 90° about 4mm from its body, then mount it in position. Note that a screw is not normally used to secure it, as it is not strictly required and would interfere with the case. However, if you are concerned about mechanical stress, you can secure it using an M3 screw and nut and drill a hole through the bottom of the case to provide clearance.

Once the regulator is in position, the three leads can then be soldered and trimmed.

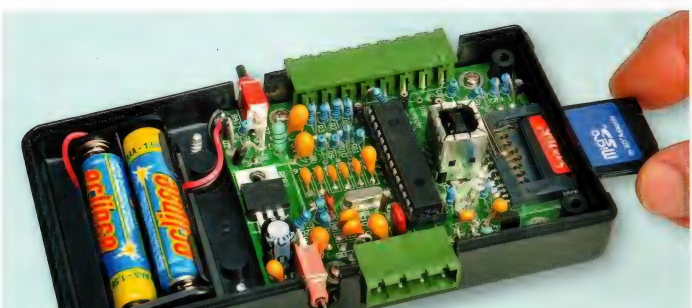
The 28-pin IC socket for the microcontroller (IC1) can now be installed. If you don't have a 28-pin 0.3-inch socket, you can use two 14-pin sockets arranged end to end. Be sure to install the socket (or sockets) with the notch facing in the correct direction (ie, towards CON4) to avoid confusion when installing IC1 later on.

Follow on by installing the capacitors. There are four types on the board: monolithic, ceramic, tantalum and electrolytic. Note that the tantalum (brown on Fig.2) and electrolytic capacitors are polarised and must be installed with the correct orientation.

Crystals X1 & X2 should be installed next. These can go in either way around but note that X1 is the 20MHz crystal while X2 is the smaller 32.768kHz crystal. Note also that X2's leads are delicate so take care when installing it. Push it down as far as it will comfortably go without stressing the leads before soldering.

The 2N7000 FET (Q1) can now go in, followed by switches S1 & S2. S1 is a mini toggle switch (S1), while S2 is a momentary pushbutton switch. Make sure they sit flush against the PC board before soldering their leads.

The 8-way and 4-way horizontal terminal block headers must also be mounted flush against the PC board. Solder these in place now, then install the vertical mounting USB Type-B socket. This socket has two mounting



The PC board is secured to the base using four self-tapping screws that go into integral pillars. Power can come from two AAA NiMH batteries, from a USB port or from some other external supply.

tabs on either side that secure it in place – solder these first, then solder the four pins towards the centre.

The adjacent 3mm blue LED (LED1) must be installed with its body 11mm above the surface of the PC board. A 10mm cardboard spacer between the leads can be used to set the height. Make sure that the LED is correctly orientated (ie, anode to the left).

Finally, connect the 2-way AAA cell holder to the supply terminals (BATT) at bottom left. The red lead goes to the "+" terminal, while the black lead goes to the remaining terminal.

That completes the PC board assembly, apart from installing IC1. This is left out of its socket until after some initial power supply checks.

First switch-on

You should use two AAA cells to initially power the unit and check the supply rails. We recommend that you use two NiMH, 900-950mAh batteries, although cells of greater or lesser capacity can also be used. Note, however, that you may have to change the 10Ω charging resistor in parallel with D2, depending on your battery type. The method used for calculating this resistor value was given in Pt.1 last month (page 43).

Make sure that the two AAA cells are charged before attempting to use them.

Assuming they are charged, insert them into the battery holder and check the voltage between pins 2 (V_{DD}) and 1 (GND) of CON3. This should be close to 3.3V. If this is incorrect, disconnect the batteries immediately and recheck your work around REG1. If there's no voltage at REG1's output, check the orientation of diode D2.

If you do get the correct 3.3V, remove the cells and insert IC1 into its 28-pin socket. **Make sure it is correctly orientated, with its notched end matching the component overlay.**

Final assembly

The case requires several cut-outs to be made before installing the PC board.

In all, five cut outs are required in the base of the case – one each for the two switches, one each for the two terminal blocks and a slot for the memory card. Fig.3 shows the locations of these cut-outs. Each can be made by drilling a line of small holes just inside the cut-out area, then breaking out the section and carefully filing to a smooth finish.

Once the cut-outs have been completed, slide the PC board into position and secure it using four of the self-tapping screws supplied with the case.

Two holes are also required in the top section (lid) of the case – one for the USB socket and one for the blue 3mm LED. The front panel artwork (see Fig.4) can be used as a drilling template. You can either copy this artwork or it can be downloaded in PDF format from the SILICON CHIP website.

If you purchase a kit, a sticky label will probably be supplied. If not, print the label out, laminate it and attach it to the lid using some silicone sealant as the adhesive.

The 2 x AAA battery holder is stored in the battery compartment of the case. It can either be left loose or it can be glued to the case lid.

Finally, complete the assembly by fitting the top half of the case into position and securing the assembly using the supplied self-tapping screws. The two 20mm-long screws go into the two top holes, while the 9mm-long screws are used for the two bottom holes. Note that the bottom two holes are accessed by removing the battery compartment cover.

That completes the assembly of the USB Data logger. The next step is to install the Windows driver and the supplied PC host program.

Installing the Windows driver

The USB Data Logger requires that a driver be installed on your Windows PC, so that it will work with the PC host program. The supplied LibUSB driver should work with almost all Windows versions, including 64-bit Windows 7 versions.

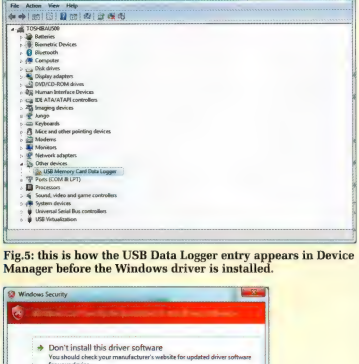


Fig.5: this is how the USB Data Logger entry appears in Device Manager before the Windows driver is installed.

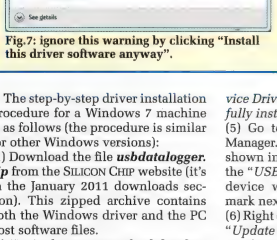


Fig.7: ignore this warning by clicking "Install this driver software anyway".

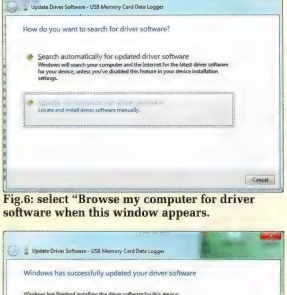


Fig.6: select "Browse my computer for driver software when this window appears.

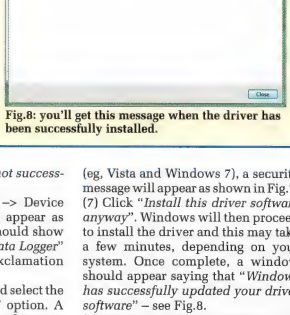


Fig.8: you'll get this message when the driver has been successfully installed.

The step-by-step driver installation procedure for a Windows 7 machine is as follows (the procedure is similar for other Windows versions):

(1) Download the file ***usbdatalogger.zip*** from the SILICON CHIP website (it's in the January 2011 downloads section). This zipped archive contains both the Windows driver and the PC host software files.

(2) Unzip the contents of ***usbdatalogger.zip*** to a directory on your hard disk (this can be done by right clicking on the file and choosing "Extract All..."). (3) Connect the USB Data Logger to your PC using a Type A to Type B USB cable (eg, Jaycar WC-7700 or Altronics P-1911A). The unit can now be powered directly from the USB port by moving switch S1's position to up. (4) Windows should now recognise the new device and prompt for the installation of the driver. It may then try to install the driver automatically but this will fail because the driver won't be part of the driver database yet.

You will then get the message "*Device Driver Software was not successfully installed*".

(5) Go to Control Panel –> Device Manager. A window will appear as shown in Fig.5 and this should show the "*USB Memory Card Data Logger*" device with a yellow exclamation mark next to it.

(6) Right click this entry and select the "*Update Driver Software*" option. A window similar to the one shown in Fig.6 will appear. Choose "*Browse my computer for driver software*".

An open file dialog will appear and you should navigate to the directory where you unzipped the driver files using the "*Browse*" button. Choose the "***USBMemoryCardDataLogger.inf***" file that appears.

For recent Windows OS versions (eg, Vista and Windows 7), a security message will appear as shown in Fig.7.

(7) Click "*Install this driver software anyway*". Windows will then proceed to install the driver and this may take a few minutes, depending on your system. Once complete, a window should appear saying that "*Windows has successfully updated your driver software*" – see Fig.8.

(8) Return to Device Manager and check that the driver has been installed correctly. You should see the "*USB memory Card Data Logger*" entry under the "*Libusb-Win32 Devices*" group, without the exclamation mark (provided, of course, that the USB Data Logger is connected to the PC).

That completes the driver installation.

Higher Baud Rates

In order to support baud rates greater than 57.6kbps (ie, up to 0.5Mbps), we have changed the two 100nF monolithic capacitors on the A0/D4 and A1/D5 inputs to 10nF.

Launching the host software

The supplied PC host program is used to compile, simulate and load custom scripts onto the USB Data Logger. It's also used to configure the unit and to transfer files to and from

it (including logs). The host program also synchronises the logger's real-time clock with the PC.

Note that since all files are stored in a FAT file system, the memory card can also be connected directly to a PC via a memory card reader. This would be desirable if transferring very large files (eg, more than 15MB), as the PC can access the memory card substantially faster than the USB Data Logger's microcontroller can.

The host software is launched by double-clicking on ***usbdatalogger.exe***. This executable program is included in the zipped archive you downloaded earlier to obtain the Windows driver. You'll find it in the same folder as the extracted Windows driver.

The easiest approach is to create a shortcut to this file on your desktop. Just right-click it and choose "*Send To Desktop*" from the drop-down menu. Once that is done, you can launch the program via the desktop icon. Fig.10 shows the opening dialog.

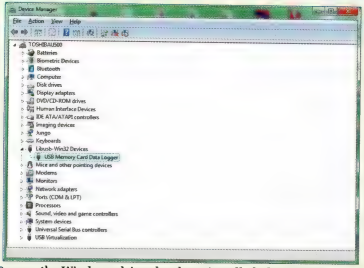


Fig.9: once the Windows driver has been installed, the USB Memory Card Data Logger entry will appear in Device Manager under "Libusb-Win32 Devices". Note that the yellow exclamation mark is now gone.

Using the host program

The PC host program is based around a Windows GUI (Graphical User Interface) and was written in Visual C++. The custom scripting language compiler and parser were also written in C++ (with help from the open source parser and lexical analyser generators, Bison and Flex). The VM engine was written using the full version of the C18 compiler from Microchip.

When launched, the host program detects the USB Data Logger automatically. You can then write, compile and send custom programs to the unit (each script is a separate file).

The main feature here is the custom scripting language support, so let's now take a closer look at this and give some examples.

Scripting language

The scripting language is a light-weight functional language implemented on a virtual machine that incorporates virtual memory support.

The best way to start is to see some sample code, which we present in the sections that follow. The PC host program converts the source code to machine code that then executes on the USB Data Logger.

At this stage, it's customary to give the "Hello World" program, as shown in Script 1.

A script consists of a header declared by the ***HEADER*** keyword, followed by its name (which you can choose), in turn followed by the header's body enclosed in curly brackets. The header can contain settings to alter

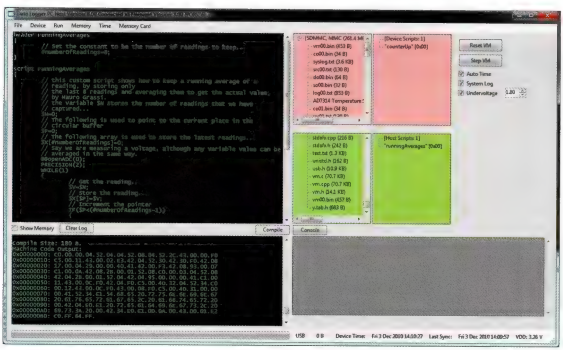


Fig.10: this screen grab shows the PC host program that's used to compile and send scripts to the USB Data Logger. It can also simulate scripts, change various settings and synchronise the time.

Script 1: Hello World Program

```
HEADER helloWorldHeader
{
    // Empty header
}

SCRIPT helloWorldScript
{
    // Simple Hello World program for the USB Data Logger, by Mauro Grassi
    PRINT "Hello World", NEWLINE;
}
```

the default behaviour of the script but in most cases, its body will be empty and the defaults can be used.

In these examples, we've used capital letters for all the keywords, to easily identify them, but the compiler accepts keywords in lower-case letters as well. However, you must use either all lower case or all upper-case letters for keywords. Usually, it is a syntax error to use a combination of upper and lower-case letters for keywords, eg, ***HEADER*** and ***heAder*** are both OK but ***heAder*** is not.

Note that all other parts of the compiler are case-sensitive. The compiler will give useful error and warning messages, together with the line and column number of the error/warning. This makes it easy to fix any syntax errors.

The header is followed by the script's body of code. This is similarly defined using the ***SCRIPT*** keyword, followed by the name of the script, followed by the custom script code, again enclosed in curly brackets. Lines starting with two slashes are comments and are ignored by the compiler (as in C). Curly brackets are used to group statements, which are always terminated by a semi-colon.

In this case, the script has a single command, ***PRINT***, which takes the argument ***"Hello World"*** (a string) and a newline. The arguments to the ***PRINT*** command are separated by commas. The output is actually written to the log file for that script (each script has its own log file – although it is also possible for a script to write another script's log file).

So that's our first program. Let's now run through a number of scenarios and present some custom scripts to do particular tasks. We've chosen the most common tasks that readers are likely to request (the sample code can also be downloaded from the SILICON CHIP website).

Reading an analog sensor

One of the most common things you'll want to do is to log a voltage that varies over time. The USB Data Logger has four analog inputs which can be used for this purpose, labelled A0-A3.

Remember that two of the analog inputs are for low voltages (0-3.6V), while the other two are for higher voltages (0-13.8V) – see Pt.1 last month. They differ only in the voltage divider used.

An analog sensor typically outputs a voltage that's proportional to the measured quantity (ie, it's ratiometric). However, although most analog sensors are ratiometric, they may differ in the specific "linear transfer function". Nevertheless, they can all be used with this data logger.

You will have to consult the datasheet for your particular sensor to configure it properly. However, the general method will be similar to the following example which describes how to connect an Analog Devices AD22103KTZ temperature sensor.

The AD22103KTZ is a 3-pin temperature sensor in a TO-92 package. Two pins are used for the supply (3.3V), while the third pin is the output. It produces an output voltage that's proportional to temperature and which ranges from 0-3.3V.

To use this sensor, connect the supply rails and connect its output pin to one of the four analog input pins. In this example, we'll use A0 as the input since it is suitable for 0-3.6V operation.

The transfer function of the AD22103 temperature sensor (according to its datasheet) is given by:

Vo = (Vs/3.3)(0.25 + 0.028T)

where Vo is the voltage at its output terminal, Vs is the supply voltage to the sensor and T is the temperature (between 0 and 100, in °C). For the sake of simplicity, let's assume that Vs = 3.3, so the equation becomes:

Vo = 0.25 + 0.028T

Rearranging this equation to get the temperature as a function of the output voltage gives:

T= (Vo - 0.25)/0.028

A suitable custom program to read this temperature sensor and log its value every minute (ie, every 60s) is shown in Script 2.

Much of this script is largely self-explanatory but we'll run through a few basics that are not obvious. Variables (which store data as 32-bit floating point numbers) and Functions (which execute code) can be both Local and Global. Local ones can only be accessed by the custom script and

Script 2: Analog Temperature Sensor

```
HEADER myAnalogSensorHeader
{

}

SCRIPT myAnalogSensorScript
{
    // Basic Script Showing How To Read and Log an Analog Sensor, by Mauro Grassi
    @@openADC(0);
    PRECISION(1);
    WHILE(1)
    {
        $T=(@@readV(0)-0.25)/0.028;
        PRINT "The Temperature is: ", $T, " degrees Celsius", NEWLINE;
        SLEEP(60);
    }
}
```

are defined there. Globals can be accessed by all running scripts and are implemented internally.

Full details of the custom scripting language's syntax, built-in functions and built-in global variables can be downloaded (in a PDF file) from the SILICON CHIP website (from the January 2011 downloads folder).

Program execution begins at the ***@@openADC(0);*** statement. As mentioned, each statement ends with a semi-colon (as in C). The ***@@openADC*** statement is a built-in global function. Their names always start with two "@" characters (so it's easy to tell which are built-in functions and which are user-defined functions, as the names of the latter always start with just one "@" character).

This particular function takes one argument, which is the channel number. In this case, ***@@openADC(0);*** simply configures the A0 pin as an analog input.

The next statement, ***PRECISION(1);*** is a built-in command (rather than a built-in global function). It simply configures the number of decimal points for printing floating point values, used later on to display the temperature.

Next, the program enters its "main loop" where it will execute its infinite loop. This is the ***WHILE(1)*** built-in command that executes the block of code enclosed in its curly brackets whenever the condition is non-zero (as in C).

The next line in the script reads: ***$T=(@@readV(0)-0.25)/0.028;*** and should be self-explanatory. There are built-in rules for which arithmetic operators take precedence over others (eg, multiplication takes precedence over addition, so that 8 * 3 + 2 = 26 rather than 40) but you can use brackets whenever in doubt. Apart from the four arithmetic operators, you can also use the "^" (exponent) and "%" (modulo) operators (unlike in C where "^" is used for XOR).

The above statement simply computes the temperature ($T) by reading the voltage at channel 0 (using the built-in global function ***@@readV***, subtracting 0.25 from the value and dividing the result by 0.028). It stores the result in the local variable $T.

Local variables are "local" to the current script, so cannot be accessed by other running scripts (as opposed to global variables which can). Local variables' names always start with a single "$" character. Global variables' names always start with two "$" characters (in analogy with global and local functions).

Once the temperature is computed and stored in the local variable $T (which is a 32-bit floating point value), the next statement logs the result to the memory card. A typical line would read: ***The temperature is: 21.4 degrees Celsius***

Script 3: Reading A Frequency Input

```
HEADER myFrequencySensorHeader
{

}

SCRIPT myFrequencySensorScript
{
    // Basic Script Showing How To Read and Log a Frequency Input, by Mauro Grassi
    @@openFrequency(0);
    PRECISION(3);
    WHILE(1)
    {
            PRINT "The Frequency is: ", @@readFrequency(0), " Hz", newline;
            SLEEP(5);
    }
}
```

The PRINT command

PRINT is a built-in command and it takes as argument a comma-separated list. Each item in the list is either a constant string, enclosed in quotes ("), or an expression (in this case the value of $T), or a special print command. In this case, we are using the ***NEWLINE*** print command to add a line return to the log file.

The last line is another built-in command: ***SLEEP***. It takes a single numeric argument, which is the number of seconds to suspend execution of the script. It simply suspends the script for the specified period, letting other scripts run. The script will be woken after this period and begin execution after the ***SLEEP*** command.

In this case, since it is the last statement in the ***WHILE*** loop, a new value will be read and logged and the process will repeat indefinitely.

Another command for sending a script to sleep is the ***SLEEPUNTIL*** command (or sleepUntil if in lowercase). Unlike the ***SLEEP*** command, it takes an absolute time (in the future), as argument. For example, writing: ***SLEEPUNTIL(16:00:10);*** will suspend the execution of the script until just after 4pm.

Now suppose you wanted to display the reading in degrees Fahrenheit as well. Then you could change the ***PRINT*** statement to:

PRINT "The temperature is: ", $T, " degrees Celsius, or ", ($T*(9/5)+32), " degrees Fahrenheit", NEWLINE;

Logging the time

Another thing you can do is timestamp the logging. You can do this using one of the built-in print functions, ***PF(#TIME)***, where ***PF*** stands for ***PRINT FUNCTION*** and is used with the built-in ***PRINT*** command. In this case, you would replace the ***PRINT*** statement with the following:

PRINT PF(#TIME), " The temperature is: ", $T, " degrees Celsius", NEWLINE;

Reading a frequency input

Reading a frequency rather than a voltage is just as easy. Script 3 shows the details.

In this case, after initalising the frequency input and setting the ***PRINT PRECISION*** to 3 decimal places, the main loop begins executing and logging the frequency on that pin in Hz, every five seconds.

Note that the frequency can be anywhere between 0.1Hz and 192kHz. To cover this wide range, three different modes are used – LOW, MEDIUM and HIGH frequency – and the mode will be changed automatically by the firmware to suit the frequency (to achieve the best accuracy).

For example, for frequencies below about 1kHz, a special LOW

How The USB Data Logger Functions

This USB Data Logger is different to most other data loggers, as it incorporates support for a scripting language. It is supplied with its own compiler and virtual machine (VM) engine.

A virtual machine is basically a software implementation of a "real" machine. In this case we are referring to a "processing machine", ie, a processor that can execute instructions to add and subtract numbers, branch on a certain condition and call subroutines, among others. An example of a well known VM is the PICAXE, which runs on a PIC.

This virtual machine can execute its own custom machine code but unlike a microcontroller, it is implemented in software. In this case, the firmware in the PIC18F27J53 microcontroller implements the VM and the Windows PC host implements both the VM and the compiler for this language. The source code is compiled into machine code and stored on a file on the memory card.

The VM engine is capable of multitasking, which means more than one custom script can run at a time. It also incorporates a virtual memory engine as well (refer to the PDF file on the Silicon Chip website for further details).

This means that, unlike a PICAXE, the RAM (random access memory) and program space available to each running script is much bigger than the few kilobytes available on the PIC itself. It is cached to the memory card and only a small amount is present in the microcontroller's memory at any time. Any accesses outside the microcontroller's memory cause a "cache miss" and go to disk (ie, to the memory card). This will be explained in more detail in Pt.3 next month.

FREQUENCY mode is used, whereas above around 12kHz a special HIGH FREQUENCY mode is used instead.

Reading a counter input

Reading a 32-bit counter value is just as easy as logging a frequency input. In this case, simply replace the ***@@openFrequency(0);*** statement by either a ***"@@openRisingCounter"*** or ***"@@openFallingCounter"*** statement (selecting to increment the count on a rising or falling edge). In addition, replace the ***@@readFrequency(0);*** statement by a ***"@@readCounter(0)"*** statement (of course, you should change the ***PRINT*** statement to suit your needs).

Note that for counters, the value is cleared (set to 0) whenever it is opened. So the counter can be "re-opened" to clear it.

Reading an I²C sensor

Let's now take a look at how to read from a digital temperature sensor using the I²C bus.

For this example, we are going to use the Analog Devices AD7414 temperature sensor. This is a 10-bit temperature-to-digital converter, using the I²C bus.

The one we are using comes in a SOT-23 6-pin package. Two pins are for the supply voltage which is 3.3V, meaning that it can be powered directly from the USB Data Logger. Another two pins, *AS* and *ALERT*, are the input and output respectively. The *AS* input can be used to choose one of three I²C addresses (to potentially use more than one of these on the same bus). These three addresses are chosen by a high, low or floating pin. We've configured ours so that the I²C address is 0x92 (hexadecimal).

The ***ALERT*** output pin will change, if configured, when the temperature exceeds the set limits. We are not using this feature in this example but you could write your own custom script to do just this.

The remaining two pins are the SCL (clock) and SDA (data) lines of the I²C interface. These are connected to digital inputs D0 and D1 respectively on the USB Data Logger.

Reading the datasheet of the AD7414 sensor tells you how to read the temperature value. This particular sensor is used by reading and writing to four internal 8-bit registers. One register (at address 0) holds the most significant eight bits of the value (you can just read this for a good approximation, or you can read the second register as well to retrieve the extra two bits for full resolution).

The "*Configuration Register*" is at address 1 and this holds the extra two bits of temperature information. It also holds extra bits to control the power to the sensor (you can put it in standby to save power and set the alert function mentioned above). The other two registers hold the minimum and maximum temperatures for the alert function, which we don't use in this example.

The address writing works as follows: the first write sets the address of the next write. For example, if we want to write to the register at address 2, we first write 2 and then the value to write to this address.

Similarly, for reading, you first write the address, then read from the sensor. So to read the value at address 1, for example, you first write 1 and then read from the device (one byte).

A program to read the temperature from the AD7414 is shown in Script 4.

In this script, we first define a constant ***#I2C_ADDRESS*** in the header (it can also be defined in the script). We then use it in all places of the code that take the I²C address of the sensor as an argument. This is a good technique since if we later want to change the I²C address, we only need to change one value (the 0x92) rather than change all places where it is used.

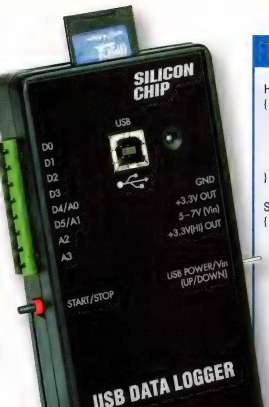
Defined constants always start with a "#" character, which is supposed to be reminiscent of the "*#define*" preprocessor directive in C. Note that these define constants can be redefined but the compiler will warn you if this happens.

We first open the I²C bus and set it to run at 400kHz, using the built-in global function ***@@openI2C***. We then set the precision to three decimal places and enter the main loop.

We declare a local variable called ***$RESULT*** which takes the value returned by the built-in global function ***@@putI2CByte***. The latter takes two arguments. The first is the I²C address, while the second is the single byte to write to the I²C bus. In this case, we simply write 0 since we interested in reading addresses 0 and 1.

The ***@@putI2CByte*** function returns a value of 1 if the command succeeded or 0 otherwise. For example, if there is no sensor connected, the function will fail. We check for this using the built-in command ***IF(){ } ELSE { }*** which executes the first block of code if the condition evaluates to non-zero or the last command block otherwise.

If the function returns 0, it logs an ***"ERROR"*** message and goes to sleep for 30 seconds before retrying.



This view shows the completed USB Data Logger with the memory card plugged in.

We read from the sensor using the built-in global function ***@@getI2C***. This function takes two arguments. The first is the address and the second is the number of bytes to read.

Note that the address register inside the sensor itself will automatically increment on each read, so we use this function to read the bytes at addresses 0 and 1. Again, it returns 1 if successful or 0 otherwise.

If successful, the data is written to an internal buffer which is a global variable ***$$I2C***. Global variables are defined for all scripts and their names always start with two "$" characters, as opposed to local variables. In this case, we use the round brackets "( )" to specify offsets of 0 and 1 to the buffer. This reads the data as a byte, whereas using square "[ ]" brackets reads it as a 32-bit floating-point number.

In this case, ***$$I2C(0)*** represents the eight MSBs (most significant bits) of the 10-bit temperature, while the two MSBs (most significant bits) of ***@@ I2C(1)*** represent the two LSBs of the 10-bit temperature. The temperature is stored in the local variable $T. The script then logs the value and ends up at the ***SLEEP(30);*** command which suspends execution for 30 seconds, before the cycle repeats.

Note that it's possible to sleep for a variable amount on each cycle. For example, in the script presented above, if the I²C temperature sensor read gives an error, we could choose to retry in three seconds, rather than 30. You would simply move the ***SLEEP(30);*** command inside the first block of the ***IF*** statement and add a ***SLEEP(3);*** command after the ***PRINT "Error", NEWLINE;*** command.

Conclusion

The general pattern in all these cases is that each script begins by executing an initialisation sequence. It then enters the main loop, executes some code and then goes to sleep until the next cycle begins.

Of course, what you do is up to you. The VM (virtual machine) engine is multitasking, so scripts are suspended after a certain amount of time if they don't voluntarily go to sleep!

As stated, the ability to run custom scripts from the memory card allows the unit to interface to almost any sensor you can think of, as well as to do novel things, such as analyse the data or monitor the sensors (ie, take different actions on certain conditions being met).

In next month's final article, we will run through the PC host program and show you how to compile and run custom scripts. More details and examples, including a "Tips & Tricks" section on how to use the custom scripting language will be given as well. SC

Script 4: AD7414 Digital Temperature Sensor

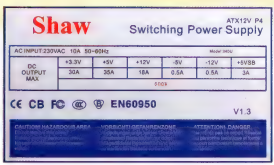
```
HEADER myI2CHeader
{
    // Basic Script Showing How To Read and Log a Temperature from an:
    // AD7414 digital I2C sensor, by Mauro Grassi.
    // Define a Constant which is the sensor's I2C Address
    #I2C_ADDRESS=0x92;
}

SCRIPT myI2CScript
{
    // Open the I2C bus, running at 400kHz...
    @@openI2C(400);
    PRECISION(3);
    WHILE(1)
    {
        // Write the Address Register
        $RESULT=@@putI2CByte(#I2C_ADDRESS, 0);
        IF($RESULT)
        {
            // Read Two Bytes From The Sensor (the address increments automatically)
            $RESULT=@@getI2C(#I2C_ADDRESS, 2);
            IF($RESULT)
            {
                // Compute the Temperature
                $T=$$I2C(0)+(($$I2C(1) & 0xC0)/256.0);
                PRINT "The Temperature is ", $T, " degrees Celsius", NEWLINE;
            }
        }
        ELSE
        {
            PRINT "Error", NEWLINE;
        }
        SLEEP(30);
    }
}
```

Your old PC might be past it... but its power supply might not be!

Cheap, High-Current Bench Supplies

by Nicholas Vinen

If you've ever had to buy a high-current bench supply, you'll know they don't come cheap. But you may well have such a supply sitting unloved and (until now!) unwanted in the back of a cupboard. It's the power supply in that old computer you never quite got around to throwing away!



Here at SILICON CHIP we are big fans of re-using and recycling old electronics. We're loathe to throw away anything which is still operational, even if it's obsolete. Manufacturing these devices involves much effort, so just throwing them away when they still work would be a shame.

This means that, among other things, we have a number of computer power supplies lying around, gathering dust. Some of these are still inside old computers which are too slow to be useful while others are left over from upgrades (where the old supply wasn't up to the task of powering a new motherboard or CPU). Others were rescued from machines that were recycled or thrown away.

Even if you don't have a spare computer power supply, these days they are cheaper to buy than an equivalent bench supply. They don't have particularly good voltage regulation, either in terms of absolute output voltage or ripple but they do have multiple voltage rails, in some cases capable of delivering upwards of 30A. If all you need is a high current fixed voltage supply (12V, 5V and possibly 3.3V), using a computer supply is a cheap and efficient option.

Note that we are not modifying the supply to provide different output voltages than those offered. Of course that can be done (see the articles in SILICON CHIP, December 1998 and October 2003) but here we are just making it much easier to use the existing rails for a bench supply.

Choosing a supply

Our first task was to decide which supply to adapt. We have some of the old "AT" supplies as well as the newer "ATX" supplies. The latter are far more common these days and safer to work with since there is no external mains power switch. As ATX supplies are now pretty much universal (and also more powerful), that is what most constructors would use.

In the end we chose a 600W Shaw brand supply. We decided against two others with higher current delivery because they are still useful for running a modern computer; and quiet and efficient to boot. Of the rest, the Shaw delivers the most current at 12V (18A) as well as a healthy 35A at 5V and 30A at 3.3V. It also has both negative outputs (-5V and -12V; some supplies lack the -5V), rated at 0.5A each.

This particular supply was bundled

A few terminals, a power switch and a LED turn a redundant PC power supply into a really useful high-current bench supply.

DANGER!

Internally, computer power supplies carry the full 230V AC mains voltage and should be regarded as potentially lethal.

Much of the exposed internal circuitry, heatsinks, etc floats at the mains voltage.

NEVER open a computer power supply case or work on the supply with the IEC mains cable plugged in (turning it off is NOT good enough!).

Heed the warnings in the text!

with an ATX case but it was noisy and inefficient at idle so we replaced it with a more expensive but much better unit, leaving this one spare. In the role of a bench supply, these issues are quite minor, as it will only be operated intermittently.

Any ATX supply is suitable for conversion but before you start, check the ratings, which are usually printed on a label attached to the side of the supply. Once you are happy that the current ratings are sufficient for your uses, you can begin the conversion, which should take no more than a few hours.

Parts

Which parts you need will vary slightly depending upon your supply and how many voltage rails you want to access. Here are the parts that we used:

- 8 binding post terminals (three black, the rest different colours)
- 1 SPDT miniature toggle switch
- 1 3mm LED
- 1 3mm LED bezel
- 1 390Ω 0.25W resistor
- 4 stick-on rubber feet
- 2 M3 x 10mm machine screws, nuts & shakeproof washers
- small piece of aluminium plate, ~35 x 35mm
- short lengths of 2.5mm and 4mm diameter heat shrink tubing
- adhesive labels

In addition you will need the following tools:

- Screwdriver
- Side-cutters
- Soldering iron
- Wire stripper
- Needle-nose pliers
- Centre punch
- Drill and drill bits (3-8mm)

Construction

First, a word on safety. Computer power supplies can kill: they rectify the 230V AC mains without the benefit of an isolation transformer and many sections of the circuitry are at full mains potential.

Never operate the supply with the lid open and always wait at least five minutes after switching off before opening it up again. There are capacitors in the switch-mode supply which, even with the supply turned off, can hold their possibly lethal charge for a couple of minutes or more.

In our supply there are exposed live mains conductors just below the lid which could easily produce a fatal shock. Other computer power supplies will certainly have similar hazards inside.

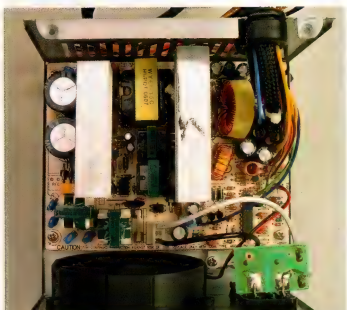
Make sure that your modifications do not interfere with the mains isolation of the PC board inside. As you can see from the internal photo of our supply, there is a row of transformers and optocouplers down the middle which form the isolation barrier between the high-voltage and low-voltage circuitry.

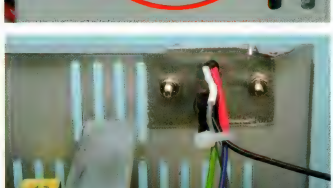
The high-voltage section contains the large mains filter capacitors. In this case they are rated at 200VDC and are connected in series (with parallel high value resistors) to handle the 325V or so which results from rectifying 230VAC. Do not mount any binding posts, switches or other components over or around this area. It is essential that the low-voltage side of the supply cannot short against a mains conductor and become live. This includes any heatsinks in the mains section; they may be live!

Start by opening up the supply (unplugged, of course!). You may need to remove one or more stickers to expose screw heads, before this is possible. The lid will typically be held on using four Phillips head screws – undo them and it should come off.

Usually, the lid clamps the grommet which holds the bundle of low-voltage carrying wires where it exits the supply. Lift the bundle out of the case and remove the grommet.

Because the wire colour coding can vary between supplies, check yours against the list in Table 1. Now that you can see the PC board, if there are any silk-screened descriptions where the wires are soldered, check that they match this list. Do not proceed





In the original supply, all the low voltage cables emerge through a hole in the case (top right of above pic), held in place by a cord-grip grommet. In the modified supply, this hole is covered by a small piece of aluminum which contains a "standby" power switch and a LED connected via a 390Ω resistor to one of the low voltage terminals

until you are sure of the function of each wire.

Metalwork

With the lid off and the low voltage wires loose you can now determine where to mount the various components and drill the holes. As you can see from the photos, we decided to mount a standby switch and indicator LED on our supply but these parts are optional. In fact the bare minimum supply requires the addition of just two binding posts, although most constructors will want to use at least three (+12V, +5V and ground).

Aside from these components you will also need to fit a small metal plate to cover the now empty wire exit hole. This will prevent any accidents involving screwdrivers or fingers going inside the supply and possibly contacting dangerous voltages.

Cut a rectangle from an aluminium sheet or off-cut which will cover the opening and provide enough space for two or more mounting screws. File it to fit; remove any burrs or lips at the same time. Then, drill holes in both the panel and the supply case to take M3 (or larger) machine screws. If you like, you can also drill holes to accept a switch and/or LED bezel in the plate, as we have. Ensure that with the cover in place, the lid closes properly, leaving no large gaps.

Now you must decide where to mount the binding posts. As mentioned previously, it is dangerous to locate these above the portion of the board which carries mains potential. Is it for this reason that we decided to mount all our additional components near the now covered wire exit hole, adjacent to the low-voltage side of the PC board. Also, be careful that the bottom ends of the binding posts or the attached wires cannot short against any heat sinks.

Once you have selected the appropriate locations, use a centre punch (or a nail and a hammer) to mark them. Don't put them right up against the edge as that will make assembly tricky. Space them apart sufficiently to give room for access to the binding post wire entry holes once they are in place (at least 16mm, more if possible).

Be gentle with the punch as the relatively thin steel can be bent easily. You just want a small depression to guide the drill. You can then proceed to drill the approximately 7mm binding post mounting holes. If you are fitting a switch and/or LED and have not already made holes for them, do so. De-burr all the holes using a larger drill bit.

After that, install the binding posts. Unscrew the plastic cap so that you can orientate them for good access to the wire entry holes. This usually means facing the hole towards the nearest edge of the case or, for those posts in the middle, diagonally. When you are satisfied, tighten the binding post nuts very firmly while preventing the posts from rotating. When you have finished, screw the plastic caps back down.

Now stick the rubber feet onto the bottom of the supply. Don't use screw-on feet as you would likely have to remove the main board from the case to get them in and it's possible that the screws could short to the bottom of the PC board and create a shock hazard.

Wiring it up

Referring to Table 1, cut off any wires which are no longer necessary. Do this as close to the PC board as possible so that the wire stubs are not free to flex and contact any other wires or components. Ideally, there should be no more than about 5mm of each wire left. Cut the connectors off the wires you will be keeping, as close to the connector as possible (to ensure the wires are long enough).

In the modified supply, all those low voltage wires now remain inside the case and connect to appropriately labelled terminals fitted to the case "lid", as shown in these two photogreaphs.

The reason that we suggest retaining thirteen black wires is that one will be used for the on/off switch and the other twelve can be split into three groups of four and soldered to the ground posts that correspond to +12V, +5V and +3.3V. These are high current outputs and this prevents the return current from one from affecting the other voltages. If you are not providing all three outputs, you don't need as many ground wires.

If you are installing a switch, cut the green wire and one of the black wires so that they are just long enough to reach its terminals, strip the ends and solder them to it. They should be attached so that when the switch is in the "on" position (ie, down for Australia and New Zealand), these wires will be connected. Otherwise, cut the wires short, solder them together and heatshrink the junction.

If you are installing a LED, trim its anode (the longer lead) and solder the 390# resistor to it. Then trim the grey and purple wires so that they will reach the LED leads and strip the ends. Solder the purple wire to the 390Ω resistor and the grey wire to the cathode lead, then heatshrink both and push the LED and bezel through the hole you made earlier.

With this arrangement, the LED lights when the supply is in standby (ie, it has mains power but it is off) and when it is on but overloaded; otherwise it is off. You can arrange for it to light under other circumstances. For example if you want it to be on whenever mains power is applied, connect the cathode to a black wire (ground) rather than grey. We shall leave other possibilities up to the reader.

Now place the lid upside-down, with the binding posts near to where the low voltage wires exit the PC board (see photo). Remove any small nuts which may be screwed onto the exposed binding posts shafts. Trim the remaining wires so that they will reach the appropriate binding posts. If you are not sure which wires go where, refer to Table 1.

There are a couple of tricks here. Firstly, make them about 20mm longer than necessary to allow for stripping the ends. Secondly, you need to check to make sure that once the wires are soldered to the binding posts, you can actually manoeuvre the lid into place. This requires leaving a little slack in them. You can see from our photos how much extra length we allowed.

Before proceeding, check if your supply has pink (+5V sense) or brown (+3.3V sense) wires. If so, they must be soldered to the same point as the red (+5V) and orange (+3.3V) wires respectively. The easiest way to do this is to twist them together as explained below. If you are not using one or both of these rails for an output, you must still connect the corresponding sense wires to at least one output wire (and heatshrink the junction).

Strip 20mm of insulation off the end of each wire and twist the strands together tightly. Wrap them around the binding post as many times as possible and flow solder onto the junction. For binding posts where more than one wire is attached, twist all the wires together into a single, large bundle before wrapping it around the post; this is much easier than trying to solder them individually.

Table 1 – ATX power supply wire colour codes

Colour	Meaning	Number to keep (if possible)
Black	Ground	13
Yellow	+12V	4
Red	+5V	4
Pink	+5V sense (optional)	1
Orange	+3.3V	4
Brown	+3.3V sense (optional)	1
Blue	–12V	1
White	-5V (optional)	1
Green	On/off switch (input, active low)	1
Purple	+5V standby	1
Grey	Power good (5V, active high)	1

Make sure that the wires do not move as you solder them and use enough solder to fully envelope the joint. Stop heating as soon as the joint has been made or else you risk damaging the wire insulation.

Use small cable ties to hold the switch and LED wires in place, so that they can not possibly come loose and contact any high voltage components. Wrap another cable tie around the bundle of wires connecting to the binding posts so that if one comes loose, it can not flap around inside the supply.

Minimum load

Some ATX power supplies will not regulate their outputs correctly if there is no external load. This is not universal, the supply we used does not have this requirement. If yours does and you do not attach a dummy load, either the output voltages will be too high or the supply will not start up properly. If you are not sure about your supply, you can proceed to the testing step and return here if either condition occurs.

The 5V rail is the most likely to require a dummy load. Usually, this rail is regulated and the others just trackit. However it is possible that some supplies regulate the rails separately and in this case each positive output will require a load.

While minimum load requirements will vary, the following 5W resistors between the output and ground should be sufficient in most cases: for the 5V rail, 27Ω; for the 12V rail, 150Ω and for the 3.3V rail, 15Ω. These resistors can be soldered between the binding post terminals.

Testing and completion

Before proceeding, check that all your solder joints are solid and that they are either insulated or can not possibly contact any exposed metal inside the supply. If you have placed the binding posts correctly you will not need to insulate them but all other joints should be heatshrinked.

Having checked that, screw the lid in place. As you fit it, take care that the wire bundles are not squashed up against any components.

Connect a multimeter set on volts mode between the +5V output and ground. Banana plug-to-banana plug leads come in very handy in this type of situation. If you have several multimeters, connect them to the other outputs. Plug an IEC power lead into the supply, flip the standby switch to on (if fitted) and then plug the mains in and switch it on.

Check that the output quickly rises to 5V (or thereabouts) and stays there. If it does not, immediately switch the supply off, disconnect it from mains and check your work. If you did not attach a load to the 5V rail then it is possible your supply requires a load; if so, follow the preceding instructions.

Assuming that all is well, you can check the other outputs and make sure they are correct. If you installed a standby switch you can also check that it works and that the LED (if installed) behaves as expected.

Finally, it is a good idea to attach adhesive labels to indicate the voltage and current available at each output. You may remember the colour coding now but it's easy to forget in future.

A label printing machine will result in a neat and legible result although we found we had to cut the labels up to get the spacing correct. An alternative would be a label prepared on your computer and possibly laminated to protect it. SC

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This remarkable collection of PDFs ***covers every issue*** of R & H, as it was known from the beginning (April 1939 – price sixpence!) right through to the final edition of R, TV & H in March 1965, before it disappeared forever with the change of name to EA.

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* Please have your credit card handy! # Don't forget to include your name, address, phone no and credit card details. * You will be prompted for required information

90W Automatic In-Car Laptop Power Supply

Automatic power supply for smaller laptops. Simply connect to your car's cigarette lighter socket and select the plug that fits your computer. Suits most laptop models. See website for compatibility.

- Input voltage: 12VDC
- Power output: 90W
- Output voltages: 15 - 24VDC
- 16 plugs
- Dimensions: 95(L) x 62(W) x 35(H)mm

MP-3324

$59.95

CREE® LED Rechargeable Spotlight

Super bright LED spotlight with 247 lumen output switchable between half and full power output. AC and 12VDC car charger are both included so it's ideal for boating, camping and other outdoor activities. LEDs indicate battery status and it also has an emergency SOS mode as well as a handy flip-up work stand for changing tyres etc. Robust ABS construction.

- Colour shaded emergency light
- Work stand
- Battery level indicator
- Weatherproof
- Multi brightness modes
- Size: 225(l) x 130(Dia)mm

SF-3309

$49.95

4 Port USB 2.0 Networking Server

Bypass the complications of device sharing and access your USB devices directly through your network. Plug this device into your router with the supplied Cat 5 cable then plug in a USB powered product and computers will be able to see and use your USB gadgets from any computer. Connecting to a wireless router will provide wireless access to USB for those who can't run any Cat 5 in the home or office network. Ideal for printers, scanners or for access to your external hard drives.

- Trouble free installation for XP, Vista, WIN 7, Bonjour for Mac OS X
- Embedded Ethernet 802.3/3u transceiver, compliant with 100BaseTX and 10Base-T PMD level standards
- Supports up to 4 devices at the same time

YN-8406

$79.95

USB Car Charger for iPad®/iPhone®/iPod®

Charge your Apple® devices while you're driving. Simply plug into the car's cigarette lighter outlet. The USB port puts out a huge 2.1A to fast charge an iPad®.

Unit includes a USB charging cable to suit iPad®/iPhone®/iPod®.

MB-3657

Due mid January 2011

$24.95

LCD Computer Screen Desk Brackets

These brackets use a C-type clamp for a powerful lock onto a variety of desk thicknesses. The monitor can be rotated 360° and also extended to approximately 400mm from its base. Both brackets feature a sleek matte black finish and can hold screens from 13-27"

Single Screen LCD Bracket

- VESA mounting (75mm x 75mm and 100mm x 100mm)
- Max load: 10kg monitor
- Dimensions: 455(H) x 490(L)mm

CW-2831

$49.95

Double Screen LCD Bracket

- VESA mounting (75mm x 75mm and 100mm x 100mm)
- Max load: 10kg per monitor
- Swivel: 360 degrees
- Dimensions: 455(H) pole height, each arm 490(L)mm

CW-2833

$69.95

6W USB Soldering Iron

You wouldn't think USB could supply enough power for a usable soldering iron, but it works by using two USB ports and produces enough heat to be a viable service tool. The iron itself is shirt pocket sized so is ideal for the roving technician. Next time someone asks you if you have a soldering iron on you, you'll be well prepared. Never be caught out again.

- Power: 4 - 6W
- Current: 800mA
- Max temperature: 480°C
- Size: 120(L)mm

TS-1537

$29.95

Inspection Camera with 2.4" LCD

With a camera diameter of only 9mm, detailed inspection of some very tight spots is possible. Its comfortable grip and forward facing controls make it easy to detect and diagnose the inaccessible. 9mm camera head for up-close visual inspections in tight spaces. Requires 4 x AA batteries.

- 2.4" colour LCD
- Adjustable brightness LED illuminator
- Forward facing controls
- Adjustable LCD brightness
- Resolution: 480 x 234 pixels
- Reach: 1m
- Attachments : Mirror, hook & pick-up magnet

QC-8710

See inside or online for full range of inspection cameras.

$199.00

USB Hubs

4-Port USB Hub

Not your average USB hub. Only 7.5mm thick, which is not much more than the USB sockets. Ideal for the traveller or student.

- Micro USB socket
- Size: 74(L) x 32(W) x 7.5(H)mm

XC-4948

Due mid January 2011

$19.95

Star shaped 4-Port USB 2.0 Hub

Compact design to reduce desk clutter. Powered from your USB port.

- Red power LED
- Supports Win98/ME/2k/XP/Vista/Win7/Mac OSX or later
- Dimensions: 50(W) x 50(L) x 15(H)mm
- 260mm long lead

XC-4302

Due mid January 2011

$12.95

2.4GHz Digital Wireless SD Card Mini DVR Systems

These mini DVR systems operate on the 2.4GHz digital band which means stable, interference-free transmissions. No cabling means easy set up. Great for a wide range of applications.

Two models are available, both include one colour outdoor day/night camera with motion sensor, a ball & socket mounting bracket, and utilise channel hopping to prevent interference. Both have easy to navigate system settings, manual recording, schedule recording or record with motion detection. Switching between QVGA (320 x 480) or VGA (higher quality 640 x 480) is configurable and playback is easy from the SD card (not included) to a PC. Both systems are expandable for up to four cameras. Quad view or single camera views are user selectable.

The QC-3630 has a wireless digital receiver/DVR that can connect to a monitor such as a TV (not included) and the QC-3632 has a 7" LCD integrated receiver/DVR with an intercom function between the camera and receiver. See website for full specs.

2.4GHz Digital Wireless Receiver with Camera QC-3632

2.4GHz Digital Wireless Display/ Receiver with Camera and Integrated 7" LCD QC-3630

Additional Camera: QC-3634 $189.00

$399.00

QC-3630

$299.00

QC-3632

www.jaycar.com.au

To order call 1800 022 888

Prices valid until 23/01/2011. Limited stock on sale items. No rainchecks. All Savings are based on Original RRP

Jaycar Electronics

Better, More Technical

Hot Deals on Party Equipment

Hot Deals This Summer!

200 WRMS 12" Party Speaker

This speaker handles a massive 200WRMS @ 8 ohms and is an excellent addition to any entertainment equipment set up. Provides good performance in difficult locations such as backyards, tents, party rooms or halls etc.

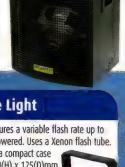
- Size approx 620(H) x 400(W) x 330(D)mm

CS-2514 WAS $249.00
Limited Stock

$219.00
SAVE $30.00

12" Subwoofer - 300WRMS

The cabinet is finished in leatherette vinyl and houses a 12", 4 ohm sub-woofer rated at 300WRMS and protected by a steel mesh grille. The speaker system is perfect for boosting the bass frequencies of music systems in bars, clubs, and parties etc.



- Impedance: 4 ohms
- Frequency Response: 40-180Hz
- Enclosure Size: 480(W) x 580(H) x 440(D)mm

CS-2518 WAS $229.00 Limited Stock

$199.00
SAVE $30.00

12" Foldback Speaker - 300WRMS

Rated at 300WRMS this wide range speaker is ideally suited for use as a foldback speaker on stage or as reinforcement in an existing system. The box features a 4 ohm, 12" sub-woofer for rumbling bass and a horn tweeter to give crisp, clear mid range and high frequencies.

- Enclosure Size: 650(W) x 330(H) x 440(D)mm

CS-2516 WAS $169.00 Limited Stock

$139.00
SAVE $30.00

PA Speaker Covers

Cover to suit CS-2514 12" PA Speaker
CS-2500 $24.95

Cover to suit CS-2516 12" Foldback Speaker CS-2501 $24.95

Cover to suit CS-2518 12" Subwoofer
CS-2502 $24.95

Buy either CS-2514, CS-2516 or CS-2518 12" Speakers & receive a FREE speaker cover to suit valued at $24.95

Party Light Set

$84.95

Liven up your next party with this lighting set. The kit includes a 20cm (8") mirror ball with a 240V AC motor, 240 volt pinspot light and stand, PAR 36 bulb and 4 coloured filters in red, amber, green and blue. Mains operated.

SL-2978

Mini Strobe Light

Great for parties! Features a variable flash rate up to 10Hz, and is mains powered. Uses a Xenon flash tube. The unit is housed in a compact case measuring 85(W) x 50(H) x 125(D)mm and is fitted with an adjustable mounting bracket.

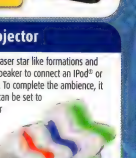
- Operates on 240VAC
- Supplied with 1.7m cable

SL-2990

$34.95

Combo Laser Light Show

Green plus red twinkle projector with the additional feature of a blue LED moving "waterfall" background.



- Scatter and strobe function
- Adjustable dimmer, rotation speed & brightness
- Dimensions: 200(L) x 85(W) x 158(H)mm

SL-3435

$299.00

Create an Atmosphere!

Rave Fog Machine

This tough fog machine will add the extra dimension to any mobile DJ setup, home party or disco lighting - with laser light shows, mirror balls and other party lighting coming out in full effect. The unit produces cloads of white fog on demand with the use of an illuminated 3m wired remote control. Features an adjustable mounting bracket, tough metal construction and fluid gauge.

- 240VAC operation
- 70 cubic metres/min fog output
- 800ml fluid capacity
- Measures 330(L) x 160(W) x 140(H)mm

AF-1214

$99.95

Fog Juice sold separately AF-1212 (1 litre) $17.95

Bubble Machine

Enhance the atmosphere at parties or special events with this affordable bubble machine. It has an easy to use on/off switch on the unit and can be powered two ways: by mains power adaptor (included) or with batteries for portable application. Requires 2 x C batteries.

AB-1220

$34.95

Bubble Mania liquid available separately AB-1222 (946ml) $6.95

Buy a Fog or Bubble machine & a bottle of matching liquid, get another bottle FREE!

Solar Powered LED Ropelights

The solar cell mounts to any flat surface and charges the built-in battery. When the sun goes down, your lights come on automatically and light the 100 red, amber and green LEDs with different selectable flashing patterns.

- Lights 10m long
- Solar panel: 148(W) x 105(H)mm

SL-2829 WAS $49.95

$29.95
SAVE $20.00

Great for the garden!

Green Laser Star Projector

Projects thousands of dazzling green laser star like formations and comes with an integrated amplified speaker to connect an IPod® or MP3s to blast tunes through the stars. To complete the ambience, it also has colour changing LEDs which can be set to beat with the music or one of the four colours (red, green, blue and white).

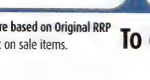
- De-stress speaker
- 6W Motion light
- HDSS noise filter technology
- Dimensions: 140(L) x 140(H) x 110(D)mm

SL-2931 WAS $149.95

$119.00
SAVE $30.95

Dynamic Unidirectional Professional Microphone

With professional styling, it features a cardioid polar pattern for reduced background noise and feedback. This microphone is ideal for use in theatres, nightclubs, public address systems and recording. Excellent frequency response and tough metal construction. Supplied with a 4m cable to 6.5mm plug.



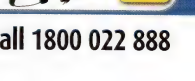
- Frequency Response: 60-12kHz
- Output Impedance: 600 Ohm
- Sensitivity: -76dB +/- 3dB @ 1kHz
- Termination: 6.5mm plug, 3 pin Cannon base

AM-4099

$29.95

DJTECH Portable Rechargeable Speaker with Amplifier

Small, light and compact. This portable rechargeable speaker is ideal for parties, beach, schools or auditoriums etc. Simply plug in an iPod®, CD player, MP3 player or microphone and it's ready to go. It includes rechargeable batteries with a runtime of approx 12 hours, a wireless hand-held microphone and a wireless transmitter with lapel mic and headset mic.



- 50 WRMS output
- Battery powered with built-in rechargeable battery
- Bass reflex enclosure
- Weight : 8kg
- Dimensions: 264(W) x 273(H) x 264(D)mm

CS-2513

$299.00

Party Celebrations!

Dual Channel / Bridged Rack Mount Amplifiers

Add a small mixer and use them as a PA amp, or standalone as a foldback amp. They have 1/4" jack inputs, balanced XLR and line-level RCA inputs. Speaker connections are by Speakon connectors or screw binding posts. They can be run as dual channel, stereo or bridged. The build quality of these amps is excellent, with very solid aluminium chassis and front panels so they are a very cost-effective solution for a pro audio application.

FROM $179.00

- Dual channel or bridged
- Fan cooled
- Separate level controls for each channel
- Clipping and overload protection indicator LEDs

Dual Channel / Bridged 200W Rack Mount Amplifier AA-0477 SAVE $20.00

Power output: 2 x 100WRMS @ 4 ohms, 1 x 200WRMS bridged @ 8 ohms
Dimensions: 480(W) x 90(H) x 247(D)mm AA-0477 WAS $199.00 NOW $179.00 SAVE $20.00

Dual Channel / Bridged 400W Rack Mount Amplifier AA-0479

Power output: 2 x 200WRMS @ 4 ohms, 1 x 400WRMS bridged @ 8 ohms
Dimensions: 480(W) x 90(H) x 247(D)mm AA-0479 WAS $299.00 NOW $279.00 SAVE $20.00

DJ Mobile 19" Rack Frame

With a total of 18 units available, fit all rack gear and keep it portable. The top section can be rotated through a range of 45° for maximum flexibility. Sturdy steel construction with castors. Ideal for DJs, PA techs, sound engineers or guitarists with large rack setups.

- Steel construction
- Hardware included
- Dimensions: 530(W) x 1050(H) x 500(D)mm

HB-6348 WAS $99.00

$89.00 SAVE $10.00

Note: Equipment not included

DJ Gear

USB Turntable with USB Direct Encoding

Transfer your vinyl collection directly to your USB device. Simply play your records, plug your USB device in and click record. When finished click record again and your music is stored onto your USB. Finished in chrome and black.

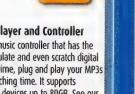
- 2 speed belt drive turntable
- Anti-skating control
- Motor off & reverse function
- RCA Phono/line output
- Dimensions : 449(W) x 145(H) x 370(D)mm

AA-0494 WAS $249.00

$239.00 SAVE $10.00

Compact USB Media Player and Controller

A USB compatible digital music controller that has the power to cue, play, manipulate and even scratch digital files. Add some FX in real time, plug and play your MP3s within any booting or searching time. It supports external USB mass storage devices up to 80GB. See our website for full specifications.



- DSP effects
- Multi function JOG mode
- VBR & CBR file support
- Dimensions: 204(W) x 215(H) x 93(D)mm

AA-0499
WAS $349.00

$299.00 SAVE $50.00

2 Channel MIDI Mixer with Virtual DJ Software

Mix, play and scratch your own MP3 tracks directly from your PC. All you need is a computer and some MP3 tracks. The mixer gives you the control you lose when going from a traditional mixer to a laptop. It sends MIDI data from the controller to your DJ software without the inconvenience of mouse control. It's a fully class-compliant USB MIDI device and complete with Virtual DJ software. This is the ultimate tool for the performing DJ. See our website for full features and specs.

AM-4252
WAS $299.00

$279.00 SAVE $20.00

For the Musician

Acoustic Guitar with Magix Music Maker Software & USB Connection

This is not just a guitar, it is a complete composition, arranging and recording package. Steel string acoustic guitar with laminated top and sides with built-in chromatic tuner and 3-band EQ. It can be directly interfaced to a PC via USB B cable or played through a high-Z output to an amplifier or to the high-Z input on a mixing desk or PA. The bundled recording software Magix Music Maker SE is one of the easiest and most intuitive programmes going around and will have you recording in seconds. Arrange, edit, build and mix tracks with intuitive, easy-to-use tools. Even the most inexperienced user of PC based recording will find it very easy to start recording tracks in seconds.

Full size acoustic guitar

- No drivers required
- Compatible with Windows XP, Vista, 7
- Intuitive drag and drop software
- Chromatic tuner
- 3-band EQ ±12dB on each band
- Requires 1 x 9V battery
- Mac compatible

CS-2559

$249.00

Digital Tuner with Metronome

Acoustic tuner and metronome in one. Combines the features of a clip-on and acoustic tuner and a metronome. You can tune by clipping on to any part of your instrument that vibrates or use the built-in microphone. Ideal for music students.

- Size: 110(L) x 35(W) x 20(H)mm

AA-2045 WAS $29.95

$19.95 SAVE $10.00

20W Guitar Practice Amp

Practice amp with enough volume for the odd garage jam. It has a headphone jack, switchable distortion and a metal grille to protect the speaker.

- CD input
- Mains powered
- 5.25" speaker
- Dimensions: 250(W) x 315(H) x 205(D)mm

CS-2554 WAS $69.95

$59.95 SAVE $10.00

UHF 2 Channel Wireless Microphone

Inexpensive dual channel UHF wireless microphone system that is not short on features. This system offers the superior performance and convenience found on more expensive models. Incorporates easy to use infrared pairing for microphones, wireless transmission can reach up to 100m line of sight. Suitable for school, churches, karaoke, weddings etc.

- Budget non-diversity receiver
- Requires 4 x AA batteries
- 2 microphones included
- Dimensions: 420(W) x 210(D) x 45(H)mm

AM-4122

$269.00

2 mics included

DMX Laser Light Show and Controller

Twinkle Laser System with DMX Control

Whether staging a dance club or house party, these laser light projectors help create the perfect dance floor atmosphere. They produce truly spectacular lighting effects with plenty of geometric patterns and overall effects to choose from.

$149.00 each

Two models available:

Red Twinkle DMX laser light show

- Dimensions: 205(L) x 80(W) x 145(H) mm SL-3431 $149.00

Green Twinkle DMX Laser Light Show SL-3433

- Dimensions: 205(L) x 80(W) x 145(H) mm SL-3433 $149.00

19" Rack Mount DMX Controller

Control multiple DMX devices, such as lights, dimmers, fog machines or laser shows with pre-programmed scenes such as fade, pan, strobe, colour etc. limited only by the capabilities of the actual DMX devices. Rack-mountable and mains powered. Visit our website for more information and programming tips.

$149.00

- Control up to 12 devices
- 16 channels per device
- Dimensions: 482(W) x 133(H) x 70(D)mm

SL-3429

Party Equipment Clearance $$ SAVE $$

Description	Cat.No	Was*	Now	SAVE
2.1 Active Satellite Mixer Amp 100WRMS	CS-2545	$949.00	$899.00	$50.00
50W Guitar Amplifier	CS-2556	$199.00	$129.00	$70.00
8-inch High-End Woofer	CW-2156	$159.00	$69.00	$90.00
Clip-on Chromatic Tuner	AA-2041	$14.95	$9.95	$5.00
Clip-on Tuner with Mic	AA-2043	$34.95	$19.95	$15.00
Compact USB Media Player and Controller	AA-0499	$349.00	$299.00	$50.00
DJ Single Headphone with Handle	AA-2059	$69.95	$29.95	$40.00
Dock Recorder for iPod®	AA-0498	$119.00	$109.00	$10.00
Glass Base Speaker Stands	CW-2843	$69.95	$30.00	$39.95
I.Scratch CD & MP3 DJ Station	AA-0493	$349.00	$299.00	$50.00
PAR36 Pin Can Light with Colour Wheel and Motor	SL-2963	$49.95	$23.95	$26.00
Rack Mount - Amplifier 2 x 80WRMS	AA-0476	$199.00	$149.00	$50.00
Rack Mount - Dual MP3 Controller	AA-0492	$499.00	$249.00	$250.00

*Off Original RRP. Limited Stock, no rainchecks, may not be available at all stores - call your local store to check stock details.

Party Celebrations

Limited stock on sale items.

All Savings are based on Original RRP

www.jaycar.com.au

Jaycar Electronics
Better, More Technical!

Stainless Steel Side Cutters and Pliers

Side Cutters

High quality small side cutters that have thick (2mm) blades and comfortable soft plastic spring loaded handles.

- 115mm long

TH-1890

$13.95

Long Nose Pliers

The partner to our TH-1890 stainless steel cutters. These have half-round smooth gripping jaws perfect for adjusting and bending components, picking up that dropped nut, etc. Comfortable soft plastic handles which are spring loaded.

TH-1893

$13.95

Buy both TH-1890 Side Cutters & TH-1893 Pliers for $20, Save $7.90

LED Panel Meters

Simple 2 or 4 wire connection for voltage or current display, perfect for automotive use. Auto zero calibration and easy to read red LED display. Give your next project a truly professional look. Cutout size 42 x 23mm.

- Easy installation
- Automatic polarity sensing
- Auto zero calibration

FROM $24.95

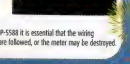
new

LED Voltmeter 0 - 30V

Power requirements: 8 - 30VDC
Maximum display count: 999
Sample frequency: 400mS
QP-5586 $24.95

LED Ammeter 0 - 50A

Power requirements: 8 - 30VDC
Maximum display count: 1999
Sample frequency: 400mS
Current shunt included
QP-5588 $39.95



Note: When connecting the ammeter QP-5588 it is essential that the wiring instructions provided with the product are followed, or the meter may be destroyed.

Industrial Storage Cases

Built for the rough and tumble of the building site, factory or workshop. Made from sturdy ABS with solid clasps and removable compartment trays. Two sizes available:

Industrial 15 Compartment Storage Case

12 compartments: 55(L) x 40(W) x 50(D)mm
3 compartments: 80(L) x 50(W) x 50(D)mm
Case size: 335(L) x 205(W) x 60(D)mm
HB-6304

$8.95

Industrial 19 Compartment Storage Case

4 compartments: 55(L) x 40(W) x 50(D)mm
8 compartments: 80(L) x 50(W) x 50(D)mm
7 compartments: 110(L) x 80(W) x 50(D)mm
Case size: 335(L) x 205(W) x 60(D)mm
HB-6305

$14.95

92 Piece 12V Rotary Tool Set

Drill, saw, sand, polish, carve or grind in your workshop or out on the road. 90+ bits and attachments cover every possible task you'll ever need. The rotary tool is rated for 12V at 12,000 RPM. Ideal for hobby or professional use. See website for full list of attachments.

Case size: 240(L) x 200(W) x 70(D)mm
TD-2451 WAS $29.95

$24.95

SAVE $5.00

Tools Clearance

$$ SAVE $$

Description	Cat. No	Was*	Now	$$SAVE$$
5-pin Male Chassis socket	PP-1072	$17.95	$4.95	$13.00
6 in 1 Foldable Keyring Tool	TH-1904	$8.95	$5.95	$3.00
Adjustable Holesaw 158 - 264mm	TD-2522	$79.95	$44.95	$35.00
Adjustable Holesaw 62 - 177mm	TD-2520	$69.95	$36.95	$33.00
CAT IV Autoranging Pocket DMM	QM-1542	$49.95	$39.95	$10.00
Epoxy Repair Putty 25g	NA-1520	$5.95	$2.95	$3.00
HSS Engineering Grade Drill Bit 3.0mm	TD-2782	$11.95	$4.95	$7.00
HSS Engineering Grade Drill Bit 7/32-Inch	TD-2715	$2.45	$1.40	$1.05
HSS Engineering Grade Drill Bit 8.0mm	TD-2768	$4.35	$1.95	$2.40
HSS Engineering Grade Drill Bit 9.5mm	TD-2772	$6.95	$2.95	$4.00
LED Screwdrivers with 10 Bits	TD-2091	$22.95	$14.95	$8.00
Magnetic Hex Tray	TH-1971	$14.95	$3.95	$11.00
Mobile Phone Tool Kit - 11 piece	TD-2024	$14.95	$9.95	$5.00
Power Driver Bit Set	TD-2036	$13.95	$9.95	$4.00
Precision Keyless Drill Chuck 3/8-Inch	TD-2011	$23.95	$19.95	$4.00
SPDT Keypad Switch with LED	SP-0775	$2.95	$1.45	$1.50
SPDT Keypad Switch with Yellow LED	SP-0778	$2.95	$1.45	$1.50
SPST PCB Mount with LED Green	SP-0616	$4.45	$2.00	$2.45
SPST PCB Mount with LED Red	SP-0615	$4.45	$2.00	$2.45
Super Soldering Starter Kit	TS-1655	$49.95	$34.95	$15.00

*Off Original RRP Limited Stock, no rainchecks, may not be available at all stores - call your local store to check stock details.

Low Cost DMM

This is a full featured meter with plug-in 4mm probes and transistor tester. The ideal first multimeter, and will give years of faithful service, in fact, you will only need to replace this meter if you require a unit with very high input impedance.

QM-1500

$9.95

Buy 2 for $15 Save $4.90

Cable Stapling Guns

Cable Stapling Guns

Take the pain out of cable installation. Instead of trying to pound away with a hammer, simply staple the cable to eaves, rafters or joists. The staples have an integral plastic cable clamp that holds the cable firmly in place. Each gun takes a variety of staples sizes to accommodate cables up to 12.5mm diameter.

$14.95

SAVE $5.00

Cable Staple Gun 4 - 10mm
Includes gun, 2 interchangeable blades and 200 staples.
TH-2610 WAS $19.95

Cable Staples Refill 4 - 6mm Pk 200 TH-2611 $9.95

Cable Staples Refill 6 - 8mm Pk 200 TH-2612 $9.95

Heavy Duty Cable Staple Gun Kit 4 - 12.5mm

Includes heavy duty die cast gun, 3 interchangeable blades and 200 staples in a carry case.
TH-2615 WAS $49.95

$44.95

SAVE $5.00

Cable Staples Refill 8 - 9mm Pk 200
TH-2616 $9.95

Cable Staples Refill 9.5 - 11mm Pk 200
TH-2617 $9.95

Cable Staples Refill 11.5 - 12.5mm Pk 200
TH-2618 $9.95

Inspection Camera

Handheld Micro Inspection Camera 17mm

The new Digitech handheld micro inspection camera allows you to perform a detailed visual inspection in hard to reach areas. Its pistol grip design and detachable wireless 2.4GHz monitor make it easy to locate and diagnose the unreachable. Ideal for security, law enforcement, building and pest inspectors etc. Requires 4 x AA batteries.

Camera:
- Image sensor: CMOS
- Resolution: 704 x 576 pixels
- Horizontal viewing angle: 50 degrees
- Minimum Illumination: 0 Lux (with LED lighting)
- Dimensions: 186(W) x 41(H) x 145(D)mm (Excluding gooseneck)

Screen:
- LCD Screen Type: 2.5" TFT-LCD
- Effective pixels: 480 x 240
- AV output for recording

QC-8700 WAS $299.00

2m Gooseneck Extension available separately QC-8702 $99.00

$249.00

SAVE $50.00

For the Hobbyist

Desktop LED Magnifying Lamp

No more fluorescent tubes to replace on your magnifying lamp. Sixty LEDs provide ample illumination, and the 3x and 12x magnifying lenses will enable you to see what you're working on with remarkable clarity and detail. Being LED, there's no delay in startup and they'll never need replacing. Ideal for hobbies, modelmaking or jewellery.

Dimensions: 320(H) x 95(Dia)mm
QM-3544

$49.95

Large Glue Gun - 240V

Great for quick and easy low stress repairs to timber, cardboard, paper, and many household materials.

Powered by 240VAC and Standards Australian approved. Perfect for occasional work around the house.
TH-1992

$22.95

Spare Glue Sticks available separately
Pk 6 TH-1995 $4.95
Pk 45 TH-1996 $17.95

The 'Fleximer' Kit

This kit uses a handful of components to accurately time intervals from a few seconds to a whole day. It can switch a number of different output devices and can be powered by a battery or mains plugpack.

- Kit includes PCB and all components
- Requires 12 - 15 VDC power

KA-1732

$19.95

Better, More Technical

All Savings are based on Original RRP
Limited stock on sale items.

To order call 1800 022 888

Back to School

Grab these accessories and make your life easy

USB Optical Mini-Mouse

If you own a laptop or netbook, there's no doubt a mouse is easier to use than a touchpad. Take this to school, the office or on business trips. It's small enough not to take up much space, but big enough to be functional. Ideal for the kiddies first starting to use computers too.

$9.95

- Scrolling wheel
- Plug and play
- Compatible with Windows 2000, XP, Vista, 7

XM-5242

90W Laptop Power Supply - Mains Powered

These universal laptop power supplies have adaptors to fit most major manufacturers' DC power input sockets, and enough power to suit most demanding laptop models. It also displays the output voltage and automatically adjusts output voltage according to which connector is fitted. 9 different connectors to suit a variety of different laptops. Check our website for compatibility.

$69.95

- Power output: 90W
- Voltage range: 12 - 22V
- 9 different connectors
- Manually selectable voltage
- Dimensions: 138(L) x 58(W) x 37(H)mm

MP-3476

*Other models available in-store. Ask our friendly staff for assistance.

External 2.5" HDD Case for SATA Drive

Instantly add gigabytes of storage to your computer or move large amount of data from one computer to another. Accepts a standard 2.5" hard drive and connects via your computer's USB port.

- Just 127mm long.

$29.95

XC-4681

*HDD not included

Voice Recorders

64MB 26-Hour Digital Voice Recorder

Record up to 26 hours of voice or notes in either dictation or conference mode, manual of VOX. Play back through the built-in 30mm speaker or use the included software. An LCD screen keeps track of everything and the simple intuitive layout as easy to use.

- Requires 2 x AA batteries
- USB cable and software included
- Variable speed playback
- Date and time-stamped recordings
- Dimensions: 97(L) x 45(W) x 18(H)mm

$49.95

SAVE $20.00

XC-0380 WAS $69.95

2GB 800 Hour Digital Voice Recorder

Never miss a quote again. Record in conference or dictation mode with either manual or automatic voice recording (AVR), and you can edit your recordings later.

- Records up to 800 hours in MP3 Format
- Date & time stamped recordings
- USB connectivity for easy PC connection (cable included)
- Variable Speed Playback
- Low battery indicator
- Requires 2 x AAA batteries
- Dimensions: 39(W) x 108(H) x 18(D)mm

$99.00

SAVE $30.00

XC-0382 WAS $129.00

Presentation Aids

RF Presenter with Laser Pointer

Combining a laser pointer and an RF remote control, this handy device gives you control over your PowerPoint presentations, training sessions or slide shows. Gives you page up/down, play and blank screen functions. Ideal for corporate trainers and conferences. USB receiver included.

$34.95

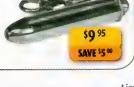
SAVE $5.00

- Battery included
- Up to 10 metre range
- Dimensions: 88(L) x 34(W) x 9(H)mm

SF-3111 WAS $39.95

Keyring Laser Pointer

This laser keyring pointer is chrome plated, and has a keychain attached. Requires 3 x LR44 batteries which are supplied.



- Very small, only 73mm long x 14.5mm dia
- Wavelength 670nm
- Max output < 1mW
- Do not stare into beam

$9.95

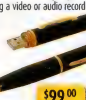
SAVE $5.00

SF-3102 WAS $14.95

4GB Pen Video Camera

new

Capture video, audio or still photos discreetly and quickly, then transfer them onto your PC via USB. The built-in memory stores up to 4GB, so there's plenty of capacity for taking electronic notes at your next meeting or protecting your legal rights by capturing a video or audio record of an event. It also functions as a conventional ballpoint pen.



- One-button operation
- Recharges via USB
- Drivers included
- Resolution: 640 x 480 VGA
- Still image resolution: 8MP
- Up to 2 hours of video or 600 photos
- Size: 148(L) x 15(Dia)mm

$99.00

QC-8004

4-Port Coloured USB Hub

Brighten up your workspace with five bright colours on your USB hub. Each different coloured port can rotate 180° for easy connection to USB devices positioned on either side of the hub.

$19.95

- USB 2.0 compatible
- Windows 2000, XP and Vista compatible
- USB lead included

XC-4300

Portable A4 Scanner

new

Almost a photocopier in your hand. Portable handy scanner can capture A4-size documents, books, letters, photos, and more directly to a Micro SD card or save image files to computer via USB cable. Unique stand alone operation that requires no computer or software to operate. The LCD displays scanning status, resolution, battery life and memory status.

- Colour sensor
- Auto power off after 3 minutes
- A4 colour contact image sensor 5136 dots
- Supports MicroSD cards up to 32GB
- Store up to 1280 x 3000PI images
- USB interface
- Dimensions: 256(L) x 30(W) x 31(H)mm

$149.00

XC-4909

Power Supplies

65W Desktop Power Supply

new

48V power supply specifically designed for power over Ethernet applications.

- Voltage: 90 - 264VAC
- Output voltage: 48V @ 1.35A
- Power output: 65W Max.
- Over voltage protection: Shutdown latch mode
- Over current protection: 2 step controlled current source
- Short circuit protection: Built-in

$59.95

MP-3249

Dual Tracking Laboratory Power Supply

This automatic constant-voltage/constant-current transfer type power supply is effectively two 0-32VDC 3 amp power supplies in one. The two outputs can be operated independently, connected in parallel, or in series for multiple output currents and voltages. Coarse and fine voltage controls are provided on both outputs, along with current limit control. Both outputs have independent digital voltage and current meters. Displays are backlit and extremely easy to read.

$349.00

SAVE $50.00

- See website or catalogue for full specifications.

MP-3087 WAS $399.00

Keyring Micro SD USB Card Reader

Microscopic would be the best way to describe this card reader at only 19 x 15mm, and that includes the USB plug. Ideal for the travelling photographers.

- USB 2.0 compliant
- Keyring lanyard included

$9.95

XC-4759

Cool Car Gear for a Hot Summer

Twin Port Subwoofer Enclosures

Dual ported subwoofer enclosures with black carpet covering. These are designed for optimal performance with the Vifa 10" and 12" subwoofers. All you need to do is to add the driver of your choice.

Note: Vifa driver not included.

10" Subwoofer Enclosure
Volume: 40.6 litres
Dimensions:480(W) x 360(H) x 280(D)mm
CS-2526 $39.95

12" Subwoofer Enclosure
Volume: 48.6 litres
Dimensions:520(W) x 385(H) x 290(D)mm
CS-2527 $49.95

Spend $200 on car audio products and receive $20 off total price. Conditions apply

*Limit 1 per customer
*See in-store/online for more details

Response Precision Car Amplifiers

With improved heat sinks and upgraded low-profile chassis design, each model delivers surprising grunt and performance in a sleek and compact package that fits neatly under a car seat. All include gold plated power and speaker terminals and variable low pass filters. Our class AB amps come with variable high pass filters and pass through RCAs; while our class D subwoofer amps feature variable subsonic filter, phase shift and master/slave operation.

2 x 80WRMS Class AB Amplifier
Dimensions: 266(L) x 235(W) x 58(D)mm
AA-0450 $149.00

4 x 50WRMS Class AB Amplifier
Dimensions: 316(L) x 235(W) x 58(D)mm
AA-0451 $199.00

2 x 150WRMS Class AB Amplifier
Dimensions: 376(L) x 235(W) x 58(D)mm
AA-0452 $229.00

FROM $149.00

4 x 100WRMS Class AB Amplifier
Dimensions: 436(L) x 235(W) x 58(D)mm
AA-0453 $299.00

500WRMS Linkable Class D Subwoofer Amplifier
Dimensions: 232(L) x 178(W) x 58(D)mm
AA-0454 $249.00

1000WRMS Linkable Class D Subwoofer Amplifier
Dimensions: 306(L) x 178(W) x 58(D)mm
AA-0455 $369.00

Windscreen Mount Suction Brackets for iPhones®

A handy device that mounts an iPhone® to the windscreen for easy access. The strong 80mm diameter suction mount will keep the iPhone® securely attached. The ball and socket joint enables positioning for maximum effectiveness. Will hold an iPhone® with or without a protective back cover.

Windscreen Suction Mount for iPhone® 3 (with or without cover)
HS-9004 $19.95
Note: iPhone® not included

Windscreen Suction Mount for iPhone® 4 (without cover)
HS-9008 $19.95

$19.95 each

Caution: Always ensure it is mounted so that it does not obstruct your view or cause a distraction.

Response Precision 4 x 100WRMS Full Range

A very efficient full range amp in a compact low-profile chassis. It is designed to drive full range speakers and delivers 550WRMS bridged. Features include insert-type connectors, variable high and low pass filters and variable bass boost. Ideally suited to our premium range of Vifa coaxials, splits and subwoofers.

- Signal/noise ratio: >90dB
- Input sensitivity: 150mV to 6V
- Bass boost: 0 -18dB @ 45Hz
- Dimensions: 292(L) x 178(W) x 58(D)mm

AA-0457

$349.00

Budget Response Car Speakers

Low cost doesn't mean low quality. Coax speakers are an ideal replacement for the standard equipment stereo speakers you get in the average car. All are equipped with titanium coated fibre woofers and silk dome tweeters for smooth high frequency response.

Response 4" Coax 2 Way Car Speakers
Power handling: 15WRMS
Nominal impedance: 4 ohms
Frequency response: 90Hz - 18kHz
Sensitivity: 83dB SPL 1W@1m
CS-2310 $24.95

Response 5" Coax 2 Way Car Speakers
Power handling: 17WRMS
Nominal impedance: 4 ohms
Frequency response: 70Hz - 18kHz
Sensitivity: 85dB SPL 1W@1m
CS-2312 $29.95

FROM $24.95

Response 6" Coax 2 Way Car Speakers
Power handling: 22WRMS
Nominal impedance: 4 ohms
Frequency response: 60Hz - 20kHz
Sensitivity: 88dB SPL 1W@1m
CS-2314 $34.95

Response 6 x 9" Coax 2 Way Car Speakers
Power handling: 27WRMS
Nominal impedance: 4 ohms
Frequency response: 55Hz - 18kHz
Sensitivity: 86dB SPL 1W@1m
CS-2316 $44.95

Economy Active 12" Subwoofer

This 12" Subwoofer in a sealed enclosure has a built-in amplifier to match. Despite its economical price the unit produces a whopping 75WRMS of astounding bass. Equipped with line level and high level inputs, it also has built-in fuse protection and wired remote level control.

- Bass boost: 12dB
- Gain: 18dB
- Power output: 75WRMS
- Dimensions: 425(W) x 355(H) x 360(D)mm

CS-2269

Unbelievable Value!

$99.00

Speaker Grilles

Car speaker grilles to suit our range of Vifa car speakers, but will suit many other car audio applications. Made from perforated steel, finished in black.

5" Car Speaker Grille - Pair	AX-3600 $9.95
6" Car Speaker Grille - Pair	AX-3602 $12.95
6 x 9" Car Speaker Grille - Pair	AX-3604 $14.95

Sound Proof Your Vehicle

Butyl Based Sound Deadening Material

By adding weight to the metal panels of your car, such as door skins, boot lids, quarter panels, etc, you can stop nasty vibrations, reduce road noise, and give your doors and boot a nice solid "thud" when they shut. Each sheet is self-adhesive, and can be easily moulded, cut and stuck onto virtually any metal surface of your vehicle's body, giving you a pleasant, quiet and comfortable ride.

- Thickness: 1.5mm
- Size: 900 x 330mm

AX-3687

$29.95

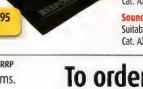
Self-Adhesive Sound Absorbing Foam

The perfect ultra light weight insulator to use in conjunction with AX-3687. This durable crush and tear- resistant material has the highest heat blocking properties available in a single layer synthetic foam-type material. Not affected by oil and does not absorb water. It provides acoustic isolation and excellent thermal insulation for roof, firewall, floor, quarter panels, doors and even as an under bonnet liner.

- Thickness: 5mm
- Size: 660 x 330mm

AX-3662

$14.95



Sound Dampening Pads

These pads are installed inside the door skins opposite the back of the speaker drivers. They absorb standing waves and resonances so you get maximum performance. Each pack includes cyanoacrylate glue for installation.

Sound Dampening Pad 7" - Pair
Suitable for 5 - 7" drivers
Cat. AX-3665 WAS $39.95

Sound Dampening Pad 12" - Single
Suitable for subs 10 - 15"
Cat. AX-3666 WAS $39.95

$29.95 each
SAVE $10.00

Better, More Technical

All Savings are based on Original RRP
Limited stock on sale items.

To order call 1800 022 888

More Car Accessories

15A Intelligent 5 Stage Battery Charger

Microprocessor controlled for charging and maintaining peak performance of your batteries. Suitable for all flooded and gel acid batteries, it compensates for temperature changes and voltage drops in the cables. It's ultra-portable with a handy storage pocket in the back for the leads.

- Charging current: 2 - 15A
- Input voltage: 220 - 240VAC
- Output voltage: 12VDC
- Dimensions: 170(W) x 230(H) x 140(D)mm

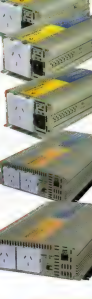
MB-3622

$149.00

Modified Sinewave Inverters

These inverters will produce mains power from your vehicle's battery. A 150W inverter will run some laptops, lights, small TVs & recharge batteries. Inverters 300W & above will also recharge power tools, run fluorescents & larger style TVs. Take your creature comforts with you when you go bush or on any road trip.

FROM $49.95



150W 12VDC to 230VAC
MI-5102 $49.95

300W 12VDC to 230VAC
MI-5104 Was $79.95
NOW $69.95 SAVE $10.00

400W 12VDC to 230VAC
MI-5106 Was $139.00
NOW $99.00 SAVE $40.00

400W 24VDC to 230VAC
MI-5107 Was $139.00
NOW $99.00 SAVE $40.00

600W 12VDC to 230VAC
MI-5108 Was $199.00
NOW $169.00 SAVE $30.00

800 Watt 12VDC to 230VAC
MI-5110 Was $249.00
NOW $199.00 SAVE $50.00

1000 Watt 12VDC to 230VAC
MI-5112 Was $329.00
NOW $299.00 SAVE $30.00

1500 Watt 12VDC to 230VAC
MI-5114 Was $499.00
NOW $449.00 SAVE $50.00

2000 Watt 24VDC to 230VAC
MI-5116 Was $599 **NOW $549** SAVE $50

BIG Savings on Inverters

Pure sinewave inverters also available. See in-store or on website.

12VDC Car Cigarette Lighter Socket 4-Way Splitter With USB Port

With the plethora of 12VDC plug appliances now available, your car's single cigarette lighter socket seems somewhat insufficient. This cigarette socket splitter enables you to power up to four 12VDC plug appliances at once. From our range alone you can plug in a laptop adaptor, a heated travel mug, a sine wave inverter, and a rechargeable LED torch. Plus it features a USB port to charge your iPhone® or other USB gadget. Mounting hardware included.

- 12VDC plug with 12m lead
- 4 x 12VDC socket outputs
- 1 x 5VDC 1A USB port
- 10A max

PS-2019

$19.95

Touch Screen LCD Monitors with USB

Touch screen capabilities enables use with a laptop/PC, games console and endless other VGA operating devices. Use it to control a computer or any other USB compatible device. The monitor can be mounted either on the bracket supplied or flush mounted with cradle. Software and adaptor cables included.

7" Touch Screen LCD Monitor
- Dimensions: 178(W) x 122(H) x 30(D)mm

QM-3744 $249.00

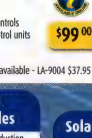
12" Touch Screen LCD Monitor
- Dimensions: 308(W) x 208(H) x 32(D)mm

QM-3746 $399.00

FROM $249.00

Steelmate Entry Level Car Alarm With Voice Function

An affordable car alarm that features voice feedback on alarm status and operational parameters such open doors etc. Comes with code hopping remotes. Other features include boot release button, valet mode, and manual override.



Includes:
- Electronic black box controller
- Shock sensor, ignition cut out relay
- Speaker siren
- Wiring looms
- Bonnet pin switch
- Car charger for the remote controls
- 2 x code hopping remote control units with a built in torch!

LA-9003

Additional/spare keyfobs also available - LA-9004 $37.95

$99.00

Twisted Pair RCA Stereo Audio Cables

Featuring RFI and EMI noise reduction to keep your car's audio sounding wholesome. Made with double aluminum foil and quality copper braid shielding for that accurate sound transfer.

- Plug to Plug
- Split center pin connectors
- Frosted jacket design
- Platinum-plated ends

5 Lengths:

0.3m	WA-1079	$14.95
0.5m	WA-1071	$14.95
1.5m	WA-1073	$19.95
2.5m	WA-1075	$24.95
5.0m	WA-1077	$29.95

Reversing Camera & Parking Kits

Rear View Mirror TFT Monitor with Camera

A complete rear-view safety package including a TFT LCD monitor and CMOS reversing and camera. it has adjustable spring-loaded brackets to fit different sized mirrors. Includes slimline remote control, second video input, 5-meter video cable.

- 7 inch screen
- Dimensions: 260(L) x 108(H) x 50(D)mm

QM-3762

$249.00

Magnetic Parking Sensor with Beeper

When you get within 1m of another car or any other object near your bumper, the alarm will sound to alert you. Simple to install, the sensor is completely concealed under the bumper with no drilling required.

- Fits any vehicle
- Easy installation
- Connects to the reversing lights

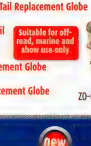
LR-8861

Note: Does not suit metal bumpers.

$49.95

LED Replacement Auto Lights

Utilising SMD LED technology, these replacement globes offer a 360° arc of illumination and high flux Piranha LEDs for high brightness. Suitable for parkers, reverse, tail and brake light replacements.



9 x White LED BAY15D Stop/Tail Replacement Globe
ZD-0361 $24.95

9 x Red LED BAY15D Stop/Tail Replacement Globe
ZD-0365 $24.95

Suitable for off-road, marine and show use only

9 x White LED BA15S Replacement Globe
ZD-0367 $24.95

9 x Amber LED BA15S Replacement Globe
ZD-0369 $24.95

ZD-0365

Solar Powered Ventilator

Completely solar powered to reduce mould, mildew, moisture and excess heat build-up in boats, caravans and RVs, or anywhere else you need air extraction. Air is drawn from inside and expelled through the vent. Cutout size: 150mm.

- Wall or roof mounting
- Stainless shroud
- Mounting hardware and gasket included
- Dimensions: 215(Dia) x 30(H)mm

MP-4559

$79.95

Car Accessories Clearance

$$ SAVE $$

Description	Cat. No	Was*	Now	SAVE
15-Inch Speaker Grill	AX-3526	$15.96	$9.95	$5.05
5-inch Speaker Grill	AX-3516	$8.50	$4.95	$3.55
Extra Heavy Duty Sound Absorbing Material	AX-3688	$18.95	$14.95	$4.00
Lamp LED MR16 1W Luxeon White 12VAC	ZD-0340	$19.95	$17.95	$2.00
Mini Blade Fuse 25A Clear	SF-5062	$1.25	$0.50	$0.75
Mini Blade Fuse 3A Pink	SF-5050	$1.25	$0.50	$0.75
Mini Blade Fuse 5A Orange	SF-5052	$1.25	$0.50	$0.75
Mini Blade Fuse 7.5A Brown	SF-5054	$1.25	$0.40	$0.85
Precision Response 4 x 100WRMS Full Range Car Amplifier	AA-0456	$399.00	$319.00	$80.00
Response 1000WRMS Linkable Monoblock Car Amplifier	AA-0460	$599.00	$349.00	$50.00
Response Piezo Tweeters	CT-1933	$6.95	$2.45	$4.50
MP3 Player to Cassette Adaptor	AR-1764	$69.95	$39.95	$30.00
Wireless MP3 Modulator For In-Car Use	AR-3118	$49.95	$39.95	$10.00
Yellow 19 LED Indicator Replacement Globe for Cars	ZD-0317	$17.95	$9.95	$8.00

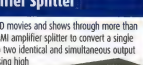
*Off Original RRP. Limited Stock, no rainchecks, may not be available at all stores - call your local store to check stock details.

Limited stock on sale items.
All Savings are based on Original RRP

Jaycar Electronics
Better, More Technical

HDMI Amplifier Splitter

Play your Blu-ray or HD movies and shows through more than one HDTV. Use this HDMI amplifier splitter to convert a single HDMI input signal into two identical and simultaneous output signals, all without losing high definition video and audio quality.



- Supports HDMI 1.3b
- Up to 2.25Gbps/225MHz

AC-1620

$99.00

5.8GHz Wireless Audio and Video Transmitter & Receiver

Beat the 2.4GHz congestion and enjoy the reliability and quality of this 5.8GHz transmitter and receiver. Provides hassle-free sharing of audio and video signals all over your house, office, factory or shop without the inconvenience and cost of running wires.

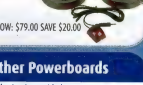
AR-1840 WAS $148.00

$128.00
SAVE $20.00

Additional receivers also available
AR-1841 WAS $99.00 NOW: $79.00 SAVE $20.00

Home Theather Powerboards

Surge protection and filtering is provided to all your home theatre equipment connected to this powerboard as well as current protection via the in-built circuit breaker.



- Provides protection to telephone, data via a network connection, satellite/cable TV & TV aerials.

MS-4024 WAS $64.95

$49.95
SAVE $15.00

Also available: **8-way High End Powerboard with Surge Protection**
MS-4029 WAS $99.95 NOW $79.95 Save $20.00

Component and Digital / Analogue Audio to HDMI Upscaler

This converter is designed to take a component video source and digital or analogue audio source (from a Toslink cable or 3.5mm socket) and scale it up for HDMI output at resolutions up to 1080p. The user menu features a comprehensive list of options to adjust for best picture and audio quality. See website for full specs.

AC-1628 WAS $369

$349.00
SAVE $20.00

Outdoor Omni-Directional UHF/VHF Amplified Digital Antenna

With inbuilt low noise and high gain booster, this compact and weather resistant outdoor digital antenna is ideally suited for caravans, boats, and other fixed or mobile applications where space is constrained or harsh environmental conditions require a little extra durability. Excellent wide frequency reception for local free-to-air analogue and digital TV, DAB+ digital radio as well as FM radio transmissions. It can be either base mounted or mast mounted. Includes mounting bracket, 12V mains power adaptor and 12V in-car charger.

- SMD technology
- Anti-rust and UV protected
- Receiver dish size: 350(Dia) x 60(H)mm
- Mounting base size: 120(Dia) x 70(H)mm

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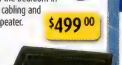

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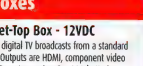

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XC-4917
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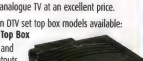

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SERVICEMAN'S LOG

A little knowledge can be a dangerous thing

A little knowledge can be a dangerous thing – or so goes the old saying. However, some people just can't help themselves. Some jobs should definitely be left to a qualified serviceman.

Items Covered This Month

- AWA-ST03 tuner
- Washing machine solenoid
- Rescuing two old organs
- Fixing electronic scales

Why do people who know absolutely nothing about electronics or electricity risk life and limb by delving into the depths of mains-powered equipment? This next story from D. S. of Maryborough, Qld tells of one such incident that could easily have ended in tragedy . . .

I recently went to pick up my son from the home of one of his school friends, after he had spent some time there. When I arrived, I was greeted by the man of the house who immediately began seeking my advice on some electronic gear.

It transpired that his problems all began after he had visited the local recycling centre. He had purchased an AWA component system consisting of a record turntable, a dual cassette deck, a CD player, a tuner and an amplifier. He paid the princely sum of $20 for the lot and, grinning from ear to ear, brought it home.

Unfortunately, he then discovered (upon plugging everything in) that the tuner was faulty. And so, ever the optimist, he removed the case and began looking for whatever was causing the lack of life in the tuner.

The tuner had a small filter network for the mains input and this was safely tucked away under a shield. A sticker on top clearly warns of the dangers of removing the shield when the unit is connected to the mains – which is precisely what he proceeded to do!

He then discovered that the GPOs (general purpose outlets, or mains sockets) in the lower section of his house were NOT covered by the home's safety switch – something he found that out the hard way when he received a severe electric shock! That put paid to any further delving and when he discovered that I was soon arriving to collect my eldest son, he decided that it would be best if I "could take a look at it".

Well, look I did but this initial inspection revealed nothing obvious. In the end, I told him that I would take the tuner home and have a closer look in the morning.

The tuner turned out to be an AWA ST-03, a neat little unit from a bygone era. Inside the chassis was the aforementioned mains filter, a small transformer, a main PC board and the tuning assembly. This assembly consisted of a tuning gang, a dial cord and an illuminated pointer, etc.

I began with the mains filter but there was nothing wrong there. The transformer was also OK, so I turned my attention to the main PC board.

Closer inspection (with my eldest son looking over my shoulder) revealed nothing untoward except for a TO-220 transistor that was cocked over at a bit of an angle. Normally, this is no indication as some components are installed this way to clear other parts. In this case, however, there was plenty of space and I also found the transistor to be quite loose, as it had no heatsink for support.

At this stage, I had no choice but to remove the PC board. This involved removing nine screws from the board itself, the front fascia panel, the knobs from the three pushbutton switches, the large tuning knob, the dial cord and the main pulley from the tuning capacitor. Getting the board out was a tight squeeze but the connecting wires were long enough to allow me to flip the board over and inspect the solder side.

This revealed that the transistor's pads had broken away from the board, so my first job was to fix this problem. I also fitted a small heatsink to support the transistor in the hope that this would prevent similar breakages in the future.

That done, I carefully inspected all the remaining solder joints under a magnifying glass. This revealed several more faulty solder joints which were all quickly repaired. I then reassembled the tuner, plugged everything back in and switched on.

Oops, it still didn't work! This was becoming frustrating.

Next, I began checking voltages. The transformer was giving a healthy 16V AC on its secondary and the 12V DC

Would You Like To Be The New Serviceman?

Our regular Serviceman of many years is retiring and we need a replacement. If you are doing regular service work and would like to take over the column, please contact Leo Simpson by emailing **editor@siliconchip.com.au**

We also welcome reader contributions for Serviceman. If you have any good servicing stories that you would like to share, why not send those stories in to us? In doesn't matter what the story is about as long as it's in some way related to the electronics or electrical industries, to computers or even to car electronics or electrics.

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HE HAD THEN DISCOVERED THAT THE GPOs IN HIS HOUSE WERE **NOT** COVERED BY THE HOME'S SAFETY SWITCH...

rail on the PC board checked OK. I then checked the DC filtering components and replaced a couple of the electros but when I came back to that TO-220 transistor, it was not conducting.

Further checks showed that the switching voltage to the transistor was correct but it wasn't responding. In the end, there was nothing for it but to remove the board again and replace the transistor.

My component tester told me it was cactus so I replaced it with a TIP42C. That fixed the problem and the tuner now powered up and began working. I checked all the parts around the transistor but these all proved to be OK.

This transistor obviously switches power to the rest of the circuit but as to why, I have no idea. Why not simply feed the supply direct from the rectifier?

The small lamp on the frequency indicator had long since died so I retrofitted a blue LED which looked quite nice. I then tidied up the loose wiring and connected my scope to the audio output.

The unit tuned accurately (which showed I had not disturbed the tuning adjustment) and the stations came in loud and clear, with little or no drift. The FM stereo detector worked well and the background noise on AM was minimal. Kudos to AWA for producing a robust unit that has stood the test of time.

I left the tuner running on my bench for a couple of days and with no further issues arising, I returned it to its owner. When I arrived, I found that he already had a visitor – a local electrician who was busy fixing the safety switch problem!

Hopefully, it's been a valuable lesson for him and he will not delve into mains-powered gear in future.

Washing machine love job

My next story comes from D. S., from Sydney's western suburbs. It seems to have caused him more than a little angst . . .

This was one of the very worst service jobs that I have tackled in the last few years; not because it had a bad outcome but because of all the frustration it caused for what should have been quite a simple job.

It began one afternoon when I got a call from Mrs Taverner who is an old family friend. She lives on her own and is a pensioner. Her washing machine was playing up and would not properly fill with water. She had not been able to do her washing for about a week due to a lot of wet weather, so she was anxious to get the machine going again.

When I arrived, it was clear that the cold-water inlet water solenoid was not functioning properly. By opening the lid and wedging the cut-out switch in the operating position, I could see that the solenoid was letting in a burst of water at full flow for about a second but then it was falling back to just a trickle.

The machine itself is about 10-15 years old and instead of the water solenoids being located under the control panel, they were at the end of the hoses, where they connect to the taps. I thought that the cold-water solenoid might be partially blocked by debris – it sometimes happens, particularly if there has been recent work on the water main in the street which has fed some dirt down the pipe.

To check this, I disconnected the hose and carefully inspected the fitting – no dirt. Just to be sure I rapped the solenoid on the side of the sink to dislodge any unseen debris and then refitted it to the tap. It was still "no go", so what next?

Well, I noticed that the hot water hose was not actually connected to the tap and I asked Mrs Taverner about this. She said that she always washed in cold water so the hose had never been connected. So, the hot-water inlet had never been used and therefore its solenoid would be in brand new condition, wouldn't it?

I quickly swapped the hot and cold inlet hoses on the back of the machine and then connected the previously unused hot water hose to the cold water tap. Now, if I selected a "hot wash", I could get a full flow of water into the machine. Mrs Taverner was delighted.

I had to let her down gently though

because I knew this was not going to be the total solution. While the machine might fill up for the wash part of the cycle, it would not then rinse because the cold water inlet to the machine was no longer being switched. Anyway, I told her that she could actually do the wash but would have to fill the machine with cold water using a bucket for the rinse. Furthermore, the "spray rinse" part of the cycle would not work either. But at least she could do a couple of loads of washing with this makeshift arrangement.

I also told her I would come back on the weekend and complete the job. This would involve swapping the internal wiring for the hot and cold water solenoids, so that the machine would once again be able to do a complete cold wash cycle.

As an aside, this machine had a range of wash cycles but had only ever been used on the same settings. I wonder how many machines are used in such a limited way? Most of them, I suspect.

Driving home that evening, I thought that the job of swapping the wiring to the two solenoids wouldn't take long; perhaps half an hour or so, since I only had to pull the back panel off, gain access to the solenoid leads, swap 'em over and the job would be done. How naive can you be?

Corroded screws

On my return, the first challenge, apart from the usual gunk under the machine when I pulled it out from the wall (to the embarrassment of Mrs Taverner), was that most of the self-tapping screws were heavily corroded and impossible to shift. I sprayed them with WD-40 and waited a few minutes while it did its work. I then removed the screws, having also detached the inlet hoses from the back of machine as well as the exhaust water hose. This inevitably spilt some water on the floor which made more mess and the tile floor slippery.

With the screws removed from the rear panel, it was clear that I had to swing it up so I could unclip it from where it fitted into the top panel which holds the lid. But of course I couldn't swing it out because it was tethered by the pump hose inside the machine, wasn't it? And I couldn't get my hands in to undo it because I couldn't pull the panel out far enough.

In the end, there was nothing for it but to remove the front panel of the machine and, of course, the screws holding that were thoroughly rusted as well. I attacked them again with WD-40 and eventually got the panel off, after which I detached the hose from the pump solenoid. I was then able to swing the rear panel out to get it off.

I should say at this stage that the machine was in a decidedly unstable state; with the two panels removed, it was threatening to collapse completely. I was also surprised at the amount of corrosion inside the cabinet. Evidently, detergent is corrosive stuff.

Anyway I was finally able to gain access to the solenoid wiring and I found that the connections were via spades inside special shrouds which clipped together. These were very difficult to pull apart and I must admit to some very unseemly language. Fortunately, Mrs Taverner had "popped out" to do some shopping in the interim.

I duly swapped over the connections and taped them up securely. Then there was the tedious job of fitting the machine back together again and it seemed even more difficult than the disassembly, given that it was really

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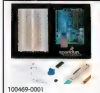
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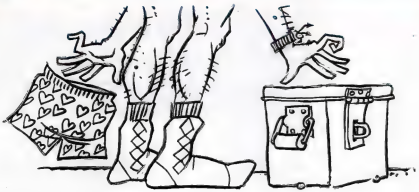

quite straightforward – just line up the various holes in the panels, insert the screws and so on; easy in theory, difficult in practice. There was more bad language, I'm afraid.

Suffice to say, I eventually got it all back together and I even replaced some of the badly rusted self-tapping screws with some new ones I had brought along. After all, I might be unfortunate enough to have to pull the machine apart again a few years down the track for another "simple" repair.

That's how it is with love jobs. There is no financial reward for doing them in the first place and you might even have a call-back. Still, I well knew that Mrs Taverner could not afford a new machine and she was very grateful to have it running once again. It will last for quite a few more years, I hope, but the corrosion will eventually do its worst.

Rescuing two old organs

Electronic organs have caused more than their fair share of problems over the years, mainly because many of these units are now quite old. Here's how P. E. of Heathcote restored two old electronic organs to health . . .

Some time ago, I bought a defunct Thomas electronic organ at a clearance sale. It only cost me a few dollars and I thought it would be good for parts.

However, on getting it home, I decided to have a go at fixing it. After all what can go wrong with these old bangers? Well, lots of things actually.

When I removed the back and opened the top, the first thing to confront me was copious amounts of dust. An air-gun on the end of my air compressor soon fixed that. However, as I was blowing away the dust, I could hear a rattle and so I looked to see what I'd broken.

The cause of this rattle turned out to be two hair pins and two brass rods, about 6mm in diameter, rolling around on the PC boards. These rods had me puzzled for a while until I noticed that the music support board had fallen down. It was normally held in place by the two brass rods and was quickly repaired.

I then cleaned the key contacts and checked the main filter capacitors, after which the old Thomas organ fired back into life.

Another organ I encountered recently (a Solina A201 made in Holland) was dead, even after de-dusting and cleaning the key contacts.

Because there was no sound whatsoever, I decided to check the power supply board first, followed by the amplifier. Fortunately, this unit came with circuit diagrams and the board overlays, so this made it easy to trace the circuit and locate everything. Ah, the good old days when things were meant to be fixed!

I began by checking the two fuses which were mounted on a PC board on top of the transformer. These proved to be corroded and broke away quite easily, so I replaced them and carefully checked the power transformer for faults before reapplying power. It was still dead so I checked the 4700µF electrolytic capacitors and the two main 2N6292 power transistors, again without result.

I then decided to remove and check the LDR system in the expression pedal. When I did so, the LDR fell off its mount. It was replaced, along with a pair of BD137/8 transistors, but it was still no go.

At this stage, I decided to take a look at the speaker wiring. However, when I touched the speaker wires, the bakelite washers that hold them in position broke away. How many more things were going to fall apart in this organ? Some neutral-cure silicone fixed this latest fault, along with a couple of pegs that were used to hold the wires in place while the silicone cured overnight.

Now, at long last, I was getting somewhere. There was a small pop from the loudspeaker and some hum at switch-on but still no sound from the keyboard.

I was close to giving up and using the organ for parts when my 15-month old dog Pangus came into the garage to "help" me. The power was on while I was checking voltages and Pangus wanted to sniff the main AY-5-1317 40-pin IC.

Concerned that she would get a zap on her wet nose, I pulled her smartly away and then the penny dropped – was there a contact problem with this IC? It was plugged into a socket and so it was easy to remove for checking.

Anyway, I removed it and cleaned the pins with some WD40 before thoroughly drying and replacing it. And that was it – sound at last.

So corrosion was the main culprit in this organ. It was just a matter of working my way through the faults one by one.

Scaling new heights

D. S. of Maryborough, Qld recently weighed into a set of electronics scales that had stopped working (pathetically weak pun intended). Here's how he tells it . . .

I have been helping my young son build a model town and he wanted scale traffic lights for the intersections. A suitable circuit based on a PICAXE microcontroller was described in Circuit Notebook of the May 2010 issue of SILICON CHIP, so I set about designing a small PC board.

When it was completed, I donned my face mask and rubber gloves and reached for my scales to measure out the etching mix. However, they would not switch on and assuming that the batteries had gone flat, I delved into the depths of my desk drawer for two

fresh replacements. I duly fitted these new batteries into the scales (not easy, as I still had my gloves on) and hit the power again but the scales still refused to work.

Stripping off my safety gear, I reached for my toolbox and began to disassemble the scales. The case screws were hidden under the rubber feet (as normal) and I also had to release the four screws which held the stress sensor in place before the case could be split apart.

The case contained the sensor, a main PC board (with the obligatory processor chip under a blob of black "goop") and the display/touch screen. The sensor and display were connected to the main board via ribbon cables and there was enough room to separate them for access.

I began by checking the supply and ground rails and everything appeared fine, with 3V appearing at various points. The scales are turned on via a touch screen and each pad on the display is held high (at 3V) and is normally pulled low when the pad is pressed. In this case, however, the data lines did not go low when the pads were pressed.

Next, I tried shorting the power switch to ground and the scales sprang to life.

Each of the other pads worked when grounded too, so the problem was in the touch display. This would be easy, I thought – just replace the touch screen.

The touch screen is a piece of glass which sits on top of the display so I only had to find the touch pad section, as the display was working fine. Unfortunately, many phone calls and emails later, I was left with no touch screen and no hope of being able to find one. The suppliers were happy to sell me some new scales but they couldn't supply a replacement touch screen.

I also received a great many looks of disbelief from some shop assistants when I enquired about replacement scales. My story of measuring out etching chemicals and weighing out surface-mount components for quantity was generally treated with derision. Most told me that they no longer sold such scales as people used them for less then legal means!

In the end, I used a small piece of stripboard and four tactile switches to make up a new switch panel. I then joined the existing ribbon cable (which fitted into the edge connector on the main board) to a short length of stripped-down IDE cable. This wasn't easy, as the original ribbon cable has very thin plastic insulation and cannot withstand excessive heat.

The other end of the IDE cable was then soldered to the stripboard, while the ribbon cable was reconnected to the main board. That done, I routed the new cable out of the case, holding it down with a few drops of hot melt glue, reassembled the case and hot-glued the new switchboard to the outside of the case, next to the display.

Finally, after refitting the batteries, I pressed the power switch and on it came. It might not look pretty but it works and the repair saved me the cost of a new set of scales which would only be used infrequently.

Now I know that these scales are not that expensive but electronics is a hobby and a passion of mine. So repairing my scales was an enjoyable and rewarding exercise. It was just a matter of weighing up the pros and cons (ouch). SC

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01/11

By JOHN CLARKE

Hearing Loop Signal Conditioner

Want to drive a hearing loop using a conventional voltage (audio) amplifier? This Hearing Loop Signal Conditioner includes signal compression and has a treble boost control to compensate for high-frequency roll-off due to loop inductance. It uses low-cost parts and is easy to build.

IF YOU ARE INSTALLING a hearing loop, you are going to need an amplifier to drive it. Commercial amplifiers specifically designed for the task are available but if you want to use a standard audio (voltage) amplifier, some form of signal conditioning is required.

For loops that are smaller than 5 x 5m, signal compression is usually all that's required. This ensures that the loop signal is adequately maintained for a wide range of input signal levels.

In addition, the frequency response should roll off above about 5kHz but this is normally taken care of by the inductance of the loop. Larger loops, however, will have greater inductance and so will roll off the response earlier. This means that the input signal must be treble-boosted before it is fed into the amplifier, to compensate for the subsequent inductive losses in the loop.

Signal conditioner

The Hearing Loop Signal Conditioner described here is designed to provide both compression and treble boost. The latter can be set by the user, so that you can tailor the signal to suit your particular loop installation. In addition, the user can vary the signal level that's fed to the amplifier.

Fig.1 shows the block diagram of the unit. As can be seen, the input stage can accept either mono or stereo line inputs and these are fed in either via RCA sockets or via a 6.35mm jack socket. Alternatively, it can accept a mono balanced input or an unbalanced input via an XLR connector.

From there, the signal is fed via level control VR1 to a low-pass filter stage. This filter rolls-off the response above 6kHz and has a Q of 0.9. The response of this stage is flat to about 5kHz and is designed to provide optimum results when the signal is subsequently fed to the treble boost stage that follows the compressor.

The compressor stage provides a nominal 2:1 compression, so that high-level signals are reduced by a factor of 2. By contrast, low-level signals are boosted by a factor of two. As a result, the compressor ensures a more or less constant signal level at its output, regardless of input signal variations, thereby preventing overload in the power amplifier.

This signal compression in turn ensures a relatively constant field strength level in the hearing loop and this can greatly improve the audibility of speech signals. Link LK4 enables

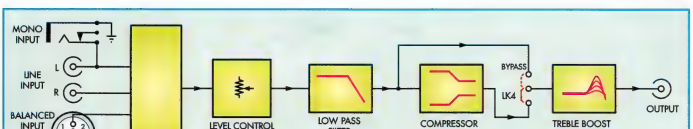


Fig.1: block diagram of the Hearing Loop Signal Conditioner. The incoming audio signal is first fed to a low-pass filter stage via a level control and then to a compressor stage. The output of the compressor then drives a treble boost circuit to compensate for high-frequency roll-off in the hearing loop.

the compressor stage to be bypassed if compression is not required.

The treble boost stage is the next in line. As previously stated, this provides boost at the higher frequencies to compensate for treble losses due to loop inductance. However, this boost stage is not like a normal treble tone control where the amount of signal boost is constant for all frequencies above the turnover frequency. Instead, it acts more like a single band boost stage in a multi-band equaliser (ie, the signal rolls off sharply at frequencies higher than the boost frequency).

The idea here is to ensure that the power amplifier is not fed boosted high frequencies above about 10kHz, as this could cause instability. If instability did occur, the loop would radiate RF signals that could interfere with other equipment.

The output from the treble boost circuit is unbalanced and is fed to an RCA socket and a 6.35mm jack socket which are wired in parallel. If necessary, a 6.35mm jack-to-XLR lead can be made up to connect to an XLR input on an amplifier.

Although not shown on Fig.1, there are several power supply options. The unit can be powered from either DC or AC and the supply can come either from a plugpack or from the supply rails of the power amplifier. Table 4 shows the various supply rail options.

Circuit details

Take a look now at Fig.2 for the full circuit details. An incoming stereo signal is applied either via the two RCA inputs or the 6.35mm stereo jack socket and is mixed using two 2.2kΩ resistors to form a mono signal (ie, when link LK1 is installed). The resulting mono signal is then applied to the non-inverting input (pin 3) of op amp IC1a via a 10µF non-polarised capacitor.

By contrast, an unbalanced mono signal is fed in either via the left channel RCA socket or via the tip connection of the jack socket. **However, if the jack socket is used, link LK1 must be removed to prevent the input signal from being divided by two by the right channel 2.2kΩ mixing resistor.** Once again, the mono signal is applied to pin 3 of IC1a.

Balanced input signals are fed in via pins 2 & 3 of the XLR connector. Pin 1 is the ground connection, pin 2 is for the non-inverted signal and pin 3 is for the inverted signal. The out-of-phase balanced signals are then fed to the non-inverting inputs (pins 3 & 5) of op amps IC1a and IC1b respectively.

IC1a & IC1b together form a balanced amplifier stage. Their non-inverting inputs are tied to ground using 100kΩ resistors, to prevent them from "floating" when there is no input connection. The associated 100pF capacitors (one across the two inputs and the others between the inputs and ground) are included to filter RF (radio frequency) signals.

In addition, the 100kΩ resistors to ground set the bias for IC1a and IC1b. These resistors connect either to the signal ground or to a half-supply ground, depending on the power supply configuration.

IC1a & IC1b operate as non-inverting amplifiers with a gain of 3. This gain is set by the 10kΩ feedback resistors and the 10kΩ resistor between their two inverting inputs. A 100pF capacitor across each 10kΩ resistor rolls off the high-frequency response above 160kHz.

The outputs from IC1a & IC1b appear at pins 1 & 7 respectively and

Main Features

- Balanced or unbalanced input
- Stereo mixing
- XLR, 6.35mm jack or phono (RCA) inputs
- Phono (RCA) or 6.35mm jack socket unbalanced output
- Low-pass and high-pass filters
- Level and tone boost adjustments
- Signal compressor
- Optional compressor bypass
- Power switch and indicator LED
- Several power supply options

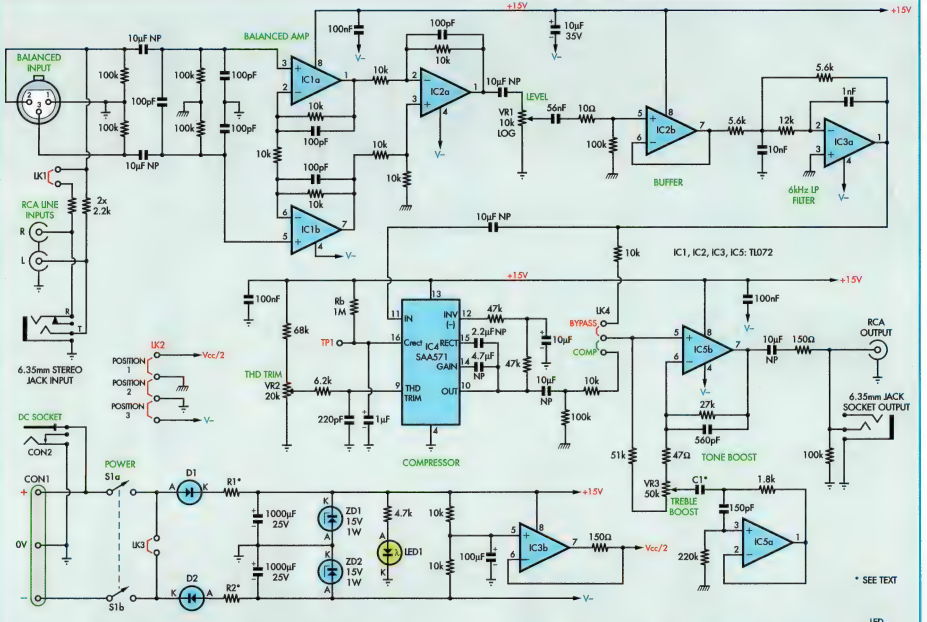
Specifications

Signal-to-noise ratio with respect to 1V in and 1V out:
(1) Compressor out: 90dB (20Hz to 20kHz filter); 99dB "A" weighted.
(2) Compressor in: 75dB (20Hz to 20kHz filter); 78.5dB "A" weighted.

Frequency response: -3dB at 43Hz and 6.6kHz, -10dB at 10kHz (no treble boost).

Treble boost: up to +16dB at 5kHz with C1 = 5.6nF. Response complements loop treble attenuation.

Signal compression: typically 2:1 to -20dB input (with respect to 1V) – see graph.



HEARING LOOP SIGNAL CONDITIONER

D1, D2: 1N4004

ZD1, ZD2

LED

Fig.2: the complete circuit of the Hearing Loop Signal Conditioner. IC1a, IC1b & IC2a form a balanced-to-unbalanced amplifier stage and this drives buffer stage IC2b via level control VR1. IC2b then drives IC3a which functions as a 6kHz low-pass filter. The signal is then fed to compressor stage IC4, while IC5b & IC5a provide treble boost to compensate for loop losses. Note the different signal ground & earth symbols used in the diagram.

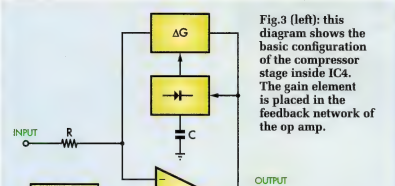


Fig.3 (left): this diagram shows the basic configuration of the compressor stage inside IC4. The gain element is placed in the feedback network of the op amp.

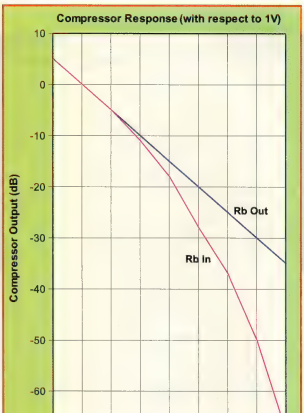


Fig.4: this graph shows the compressor's output as a function of its input signal. It provides a nominal 2:1 compression but has a non-linear response with Rb in (see text).

are fed to pins 2 & 3 of differential amplifier stage IC2a. For signals from IC1a, IC2a functions as an inverting amplifier with a gain of -1. By contrast, signals from IC1b are first divided by two (using two 10kΩ resistors) before being fed to IC2a which now functions as a non-inverting amplifier with a gain of 2. This means that the overall gain from pin 7 IC1b to pin 1 of IC2a is +1.

As a result, the signals at the output of IC2a are now in phase and so they are added or summed to give IC2a an overall gain of 2 (ie, for balanced input signals). The resulting unbalanced signal is AC-coupled to level control VR1.

By contrast, if the input signal is unbalanced, it is simply fed via IC1a and IC2a. In that case, IC2a has an overall gain of -1.

VR1 is included to allow adjustment of the compressor input level (more on this shortly). However, the signal from VR1 is not fed directly to the compressor stage (IC4). Instead, it's first fed via a 56nF capacitor and 10Ω resistor to unity gain buffer stage IC2b which has its input is biased at signal ground via a 100kΩ resistor. The 56nF coupling capacitor rolls off the frequency response below 28Hz.

IC2b provides a low-impedance drive for the following low-pass filter which comprises IC3a and its associated resistors and capacitors. This filter stage is a multiple-feedback 2-pole design that rolls off the response at 6kHz. This ensures a flat response up to 5kHz which is the recommended minimum high-frequency response for a hearing loop.

Compressor stage

IC3a's output appears at pin 1 and is fed to pin 11 of IC4, an SAA571 compander IC. The word "compander" is a contraction of the words "compressor" and "expander" and means that the device can be used as either a signal compressor or a signal expander.

In this case, the SAA-571 is used in its compressor mode.

The device itself contains two full-wave averaging rectifiers, two gain elements and a dual op amp for stereo use. Only one channel is used here, however.

When the device is used as a compressor, the gain element is placed in the feedback network of the op amp, ie, between its inverting input and output. Fig.3 shows the general arrangement. As can be seen, the input is fed in via resistor "R" to the inverting input, while the non-inverting input is biased at a voltage above ground (ie, to Vref) to allow the output to swing symmetrically.

In operation, the full-wave averaging filter monitors the op amp's output and rectifies the signal. This rectified signal is averaged to provide a DC voltage that controls the gain element. If the signal level is low, then the DC control voltage is low and the gain element's resistance is high. As a result, the compressor provides a high signal gain from input to output.

Conversely, if the signal level is high, the control voltage is also high and this reduces the gain element's resistance to lower the gain. As a result, low-level signals are boosted while high-level signals are reduced.

Fig.4 plots the compressor's output response as a function of its input signal level. Basically, the compressor is set up so that it provides a nominal 2:1 compression. In this circuit, however, as the signal reduces, the gain becomes non linear and is also reduced. This is due to the addition of resistor Rb (see Fig.2). Without this resistor, the compressor would operate with a nominal 2:1 compression for signals down to -80dB (ie, below the 0dB reference).

Compressor circuit

The SAA571 (IC4) requires only a few extra parts to produce a working compressor stage. As shown, the signal from pin 1 of IC3a is AC-coupled to IC4's pin 11 input, while the output (pin 10) is AC-coupled to the gain cell (pin 14) and the rectifier (pin 15). In addition, two 47kΩ resistors are used provide a DC feedback path from the output to the inverting input (pin 12) of the internal op amp.

The smoothing (averaging) filter capacitor for the rectifier is at pin 16

Parts List For Signal Conditioner

1 PC board, code 01101111, 118 x 102mm
1 plastic instrument case, 140 x 110 x 35mm
1 front panel label, 133 x 28mm
1 rear panel label, 133 x 28mm
3 PC-mount single RCA sockets
2 6.35mm stereo PC-mount jack sockets
1 3-pin XLR panel socket (optional)
1 PC-mount DC socket
1 DPDT PC-mount toggle switch
1 10kΩ log 16mm potentiometer (VR1)
1 20kΩ horizontal trimpot (VR2)
1 50kΩ linear 16mm potentiometer (VR3)
4 DIP8 IC sockets (optional)
1 DIP16 IC socket (optional)
1 3mm green LED (LED1)
1 3-way screw terminal block (5.04mm pin spacing)
1 11-way pin header strip with 2.54mm spacing (to be cut into 4-way, 3-way & 2 x 2-way headers)
5 pin header jumper shunts
1 260mm length of 0.7mm tinned copper wire
4 No.4 self-tapping screws
5 PC stakes

Semiconductors

4 TL072 dual op amps (IC1-IC3, IC5)
1 SAA571N Compandor IC (IC4) (available from Futurelec)
2 15V 1W zener diodes (ZD1,ZD2)
2 1N4004 diodes (D1,D2)

Capacitors

2 1000µF 25V PC electrolytic
1 100µF 16V PC electrolytic
6 10µF NP PC electrolytic
2 10µF 35V PC electrolytic
1 4.7µF NP PC electrolytic
1 2.2µF NP PC electrolytic
1 1µF 16V PC electrolytic
3 100nF MKT polyester
1 56nF MKT polyester
1 10nF MKT polyester
1 1nF MKT polyester
1 560pF ceramic
1 220pF ceramic
1 150pF ceramic
6 100pF ceramic
C1 1.2nF - 5.6nF (see Table 3)

Resistors (0.25W, 1%)

1 1MΩ	1 6.2kΩ
1 220kΩ	2 5.6kΩ
7 100kΩ	1 4.7kΩ
1 68kΩ	2 2.2kΩ
1 51kΩ	1 1.8kΩ
2 47kΩ	2 150Ω
1 27kΩ	1 47Ω
1 12kΩ	1 10Ω
11 10kΩ	

R1, R2 (see Table 4)

(1µF), while Rb has a value of 1MΩ and is connected between pin 16 and the +15V supply rail. As stated, this ensures non-linear compression at low signal levels. Basically, it prevents the compressor from providing gain at these levels as this would only increase the noise.

Trimpot VR2 is there to provide the distortion trim adjustment by setting the voltage applied to pin 9. Normally, this trimpot is set to its mid point. However, if a distortion analyser is available, VR2 can be set for minimum total harmonic distortion (THD).

The compressor stage output at pin 10 is AC-coupled via a 10µF capacitor and 10kΩ resistor to the treble boost output stage which is based on op amps IC5b & IC5a. Note, however, that the compressor can be bypassed by installing link LK4 in the BYPASS position. In that case, IC3a's output is fed directly to IC5b via a 10kΩ resistor.

Treble boost

As stated, the treble boost circuit works like an equaliser. This operates over a narrow frequency band and the centre frequency is set by changing a capacitor to suit the hearing loop.

The equaliser is tuned to a particular centre frequency and the conventional way of doing this is to use an LC (inductor-capacitor) network. The basic scheme for a single-band equaliser is shown in Fig.5.

Op amp IC5b is connected as a non-inverting amplifier. Its feedback network includes potentiometer VR3 which has its wiper connected to ground via an LC network. This LC network sets the centre-frequency of the band.

It works like this: when VR3 is wound fully to the left, the LC circuit has no effect on the frequency response. In other words, an input signal passes through the circuit unchanged except for gain (ie, it has a flat frequency response). This is the "flat" setting for the equaliser.

Conversely, when VR3 is rotated fully right to its "boost" setting, the LC network is connected directly to the inverting (-) input of IC5b, shunting the negative feedback to ground. At the resonant frequency, the impedance of the LC network is at a minimum. As a result, the feedback will be reduced and the gain will be at a maximum.

Intermediate settings of VR3 vary the gain at the resonant frequency accordingly. The centre (resonant) frequency is obtained from the formula: $f = 1/2\pi\sqrt{(LC)}$.

No inductor

Although we could use an inductor in the resonant circuit, our final circuit (Fig.2) uses a "gyrator" instead. A "gyrator" is a pseudo inductor and is based on an op amp and a low-value capacitor. Fig.6 shows the arrangement.

In an inductor, the current lags the voltage waveform by 90°. However, the reverse is true for a capacitor – in this case, the voltage lags the current by 90°. Therefore, in order to simulate an inductor, this voltage lag with respect to current must be reversed.

The circuit of Fig.6 works as follows. When an AC signal (Vin) is applied to the input, current (Iin) will flow through capacitor C and resistor R. This produces a varying voltage at IC5a's non-inverting (+) input.

IC5a is connected as a voltage follower. As a result, this op amp will reproduce its input voltage across resistor Rout at its output. This in turn causes a current (Iout) to flow in Rout and this is subtracted from the input current. The resulting total current lags the input voltage by 90°.

As a result, as far as the signal source is concerned, the circuit behaves as an inductor. The value of this "simulated inductance" is given by the equation: L = R x Rout x C. By substituting the gyrator for the inductor in the circuit of Fig.5, we have the basis for a complete single-band equaliser.

The value of C1 will depend on the size of the hearing loop. Basically, this capacitor is chosen so that the

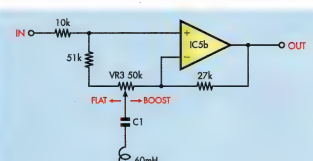


Fig.5: a conventional single-band equaliser uses an LC network to set the centre frequency of the band.

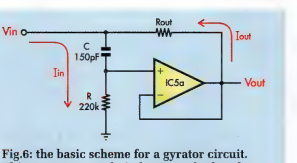


Fig.6: the basic scheme for a gyrator circuit. This acts as a pseudo inductor and takes the place of the inductor shown in Fig.5 for the treble boost circuit.

equaliser provides the correct boost curve to compensate for treble losses due to loop inductance. Smaller loops require a higher centre frequency and a shallower boost slope up to 5kHz for the equaliser. Any boost above about 6kHz is restricted due to roll-off from the 6kHz low-pass (LP) filter (IC3a). In addition, IC5b's 27kΩ feedback resistor and its parallel 560pF capacitor provide extra roll-off above 10kHz.

The output from the treble boost circuit appears at pin 7 of IC5b and is AC-coupled to the output sockets via a 10µF capacitor and a 150Ω isolating resistor. The latter prevents IC5a from oscillating with leads that present a capacitive load. The output can be taken either from the RCA socket or from a 6.35mm jack socket.

Power supply

Power for the circuit can come from either a 12-60V DC source, a ±12-60V DC source or an 11-43VAC source. The current requirements are quite modest at just 30mA.

The simplest supply arrangement is to use a ±12-60V DC source (this type of supply can often be found in existing amplifier equipment). The positive rail is simply connected to the "+" supply input, the negative rail to the "-" input and the ground to 0V. Diodes D1 & D2 provide reverse polarity protection, while two 1000µF capacitors filter the supply rails.

Zener diodes ZD1 & ZD2 protect the op amps by conducting if the input voltage rails exceed ±15V. Resistors R1 and R2 in series with each supply line limit the current through ZD1 and ZD2 when they conduct. Their values depend on the supply rail voltages and are chosen from Table 4.

Note that, with this supply arrangement, the two different grounds on the circuit are tied together by placing link LK2 in position 2 (see Table 4). This biases the op amp inputs at 0V so that the signal swings symmetrically above and below ground.

Using an AC supply

An 11-43VAC supply can also be used to derive positive and negative supply rails. In this case, the "+" and "-" inputs are connected together using link LK3 (following S1a & S1b) and the supply is connected between either of these two inputs and the 0V terminal (ie, between either "+" and 0V or between "-" and 0V of CON1).

With this supply configuration, diodes D1 & D2 function as half-wave rectifiers, with filtering provided by two 1000µF capacitors. Diode D1 conducts on the positive half-cycles to derive the positive rail, while D2 conducts on the negative half-cycles to derive the negative rail.

As before, the two grounds are connected by installing LK2 in position 2, while R1 and R2 are chosen from Table 4 according to the supply voltage.

12-60V DC supply

The circuit is a little more complicated for a single-rail 12-60V DC supply. That's because the signal can no longer swing below the 0V rail, since there's no negative supply rail. As a result, the op amps must be biased to the mid-supply voltage, so that the signal can swing symmetrically about this voltage.

This mid-supply voltage is produced using a voltage divider consisting of two 10kΩ resistors between the positive supply rail and ground. A 100µF capacitor filters this half-supply rail and this is fed to IC3b.

IC3b is wired as a unity gain buffer stage. Its output at pin 7 provides the

Choosing An Amplifier To Drive The Loop

Commercially available hearing loop amplifiers use current drive for the loop. An advantage of these amplifiers is that they do not require any treble boost to compensate for losses due to loop inductance.

Note, however, that the Hearing Loop Signal Conditioner can still be used with current-drive amplifiers to provide signal compression and level control. In this role, the treble boost control should be set to flat.

The Hearing Loop Signal Conditioner can also be used with voltage amplifiers, in which case all its features, including treble boost, can be used. The voltage amplifier chosen must be capable of driving a 4Ω load and it must also be unconditionally stable. This latter requirement is important because we don't want the amplifier to oscillate at a very high frequency and cause RF (radio frequency) signals to be radiated from the hearing loop.

Many commercially made amplifiers should be suitable, as should most of the audio amplifier designs described in Silicon Chip. Table 5 shows some of the recent Silicon Chip amplifiers and the recommended loop size that could be used with each. The amplifier power requirement for the loop size takes into account the fact that the loop will be about 1.7m away from the listening position.

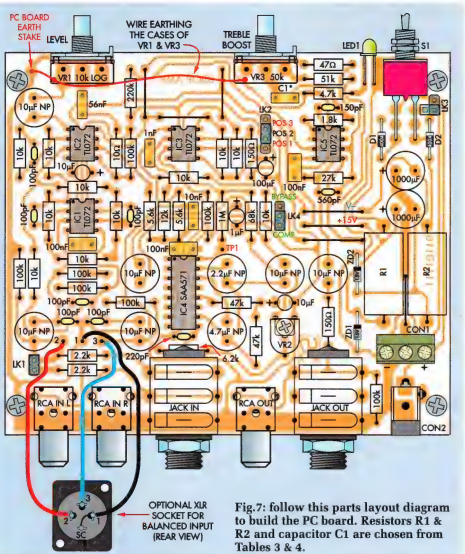


Fig.7: follow this parts layout diagram to build the PC board. Resistors R1 & R2 and capacitor C1 are chosen from Tables 3 & 4.

half-supply rail (Vcc/2) via a 150Ω decoupling resistor. This is then used to bias the remaining op amps.

For this DC supply option, two links are required for LK2 – one in position 1 and the other in position 3. The position 1 link connects the Vcc/2 rail to the signal ground, while the position 3 link connects the negative supply pins of the op amps (pin 4 in each case) to ground.

Regardless of the power supply type used, LED1 lights when power is applied via switch S1. This LED is powered from the +15V supply rail via a 4.7kΩ current-limiting resistor. Note that the +15V supply rail will be at about +12V if a 12V DC supply is used.

The AC-coupling capacitors at the inputs and outputs of the various op amps remove any DC component from the signal. These capacitors are necessary when the op amp outputs are biased at half supply. For the other supply options, the capacitors prevent DC coupling to the input stages of IC1a and IC1b and prevent DC flow in the level control.

Construction

Refer now to Fig.7 for the assembly details. It's easy to build, with all parts mounted on a PC board coded 01101111 and measuring 118 x 102mm. This board is housed in a plastic instrument case measuring 140 x 110 x 35mm.

Begin by checking that the PC board fits correctly inside the case and that

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	7	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	68kΩ	blue grey orange brown	blue grey black red brown
❑	1	51kΩ	green brown orange brown	green brown black red brown
❑	2	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	1	27kΩ	red violet orange brown	red violet black red brown
❑	1	12kΩ	brown red orange brown	brown red black red brown
❑	11	10kΩ	brown black orange brown	brown black black red brown
❑	1	6.2kΩ	blue red red brown	blue red black brown brown
❑	2	5.6kΩ	green blue red brown	green blue black brown brown
❑	1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	1	1.8kΩ	brown grey red brown	brown grey black brown brown
❑	2	150Ω	brown green brown brown	brown green black black brown
❑	1	47Ω	yellow violet black brown	yellow violet black gold brown
❑	1	10Ω	brown black black brown	brown black black gold brown

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
56nF	.056µF	56n	563
10nF	.01µF	10n	103
1nF	.001µF	1n	102
560pF	NA	560p	561
220pF	NA	220p	221
150pF	NA	150p	151
100pF	NA	100p	101

Table 3: C1 vs Loop Size

Loop Size	C1
20m square loop	5.6nF (5n6 or 562)
15m square loop	4.7nF (4n7 or 472)
12m square loop	3.9nF (3n9 or 392)
10m square loop	3.3nF (3n3 or 332)
7m square loop	2.2nF (2n2 or 222)
5m square loop	1.8nF (1n8 or 182)
3m square loop	1.2nF (1n2 or 122)

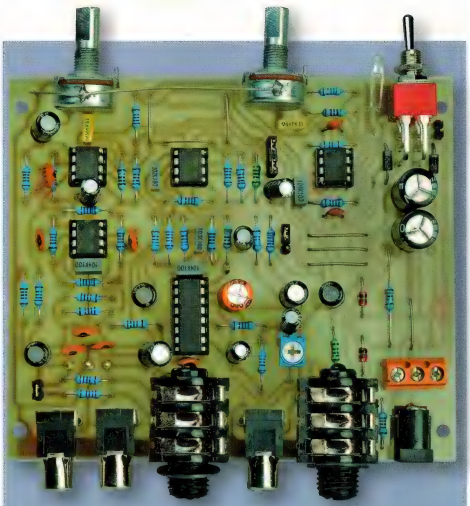
its four corner mounting holes line up with the integral mounting bushes. These mounting holes should be 3mm in diameter. If not, drill them out to size.

The next step is to check the board for any defects, such as breaks in the copper tracks and shorted tracks and pads. That done, start the assembly by installing the six wire links and the resistors. **Don't forget the link between resistors R1 & R2 but leave R1 and R2 out for the time being.**

Table 1 shows the resistor colour codes but you should also use a DMM to check each resistor as it is installed.

Follow these parts with diodes D1 & D2 and zener diodes ZD1 & ZD2. Check that these parts are correctly orientated before soldering their leads, then install three PC stakes to terminate the XLR socket wiring. An additional PC stake is then installed immediately to the left of potentiometer VR1 (this connects to the ground track and is used to terminate a length of tinned copper wire that connects to the bodies of the two pots).

The 2-way, 3-way and 4-way pin headers (for LK1, LK2, LK3 & LK4) are next, followed by the IC sockets. Be sure to install the sockets with their notched ends orientated as shown on Fig.7.



This view shows the completed PC board. Omit the two RCA input sockets and the adjacent 6.35mm jack socket if you intend using an XLR input connector.

Alternatively, the five ICs can be soldered directly to the PC board.

Now for the capacitors. The MKT types can go in first, followed by the electrolytics. The electros marked "NP" are non-polarised and can go in either way around but the rest must be correctly orientated. Capacitor C1 is selected from Table 3 to suit the size of the hearing loop.

Trimpot VR2 can now be installed, followed by the various connectors. However, if you are using an XLR connector for the input, then the left and right RCA sockets and the adjacent 6.35mm jack socket (input) should be omitted. This is necessary to allow space for the XLR connector on the rear panel.

If you are not using the XLR connector, then install the RCA sockets and the 6.35mm jack socket as shown on Fig.7. Make sure that all the connectors are correctly seated on the PC board before soldering their leads.

Switch S1 can also be installed at this stage, along with 3-way terminal block CON1. In addition, install power socket CON2 if you intend using either a single rail DC supply or an AC supply (eg, a DC or AC plugpack).

Alternatively, if you intend using a dual-rail supply (ie, with "+" and "-" rails), then you should omit CON2. A grommet is then later installed on the rear panel at CON2's location and the supply leads run through this to CON1.

Installing the pots & LED1

The two potentiometers (VR1 & VR3) are mounted directly on the PC board. Before mounting them, trim their shafts to 10mm (as measured from the screw thread bush) to suit the knobs. The pots are then pushed all the way down onto the board (VR1 is the 10kΩ log pot) and their terminals soldered.

Once they are in position, earth the two pot bodies by running a length of tinned copper wire between them and soldering one end to the PC stake immediately to the left of VR1. Note that it will be necessary to scape away

Table 4: Choosing R1 & R2 & Setting The Supply Links

Input Voltage	R1	R2	Links	Power Input
±60VDC	1.2kΩ 5W	1.2kΩ 5W	LK2 position 2, LK3 out	+, 0, -
±55VDC	1kΩ 5W	1kΩ 5W	LK2 position 2, LK3 out	+, 0, -
±50VDC	820Ω 5W	820Ω 5W	LK2 position 2, LK3 out	+, 0, -
±45VDC	680Ω 5W	680Ω 5W	LK2 position 2, LK3 out	+, 0, -
±40VDC	560Ω 5W	560Ω 5W	LK2 position 2, LK3 out	+, 0, -
±35VDC	470Ω 5W	470Ω 5W	LK2 position 2, LK3 out	+, 0, -
±30VDC	390Ω 5W	390Ω 5W	LK2 position 2, LK3 out	+, 0, -
±25VDC	270Ω 5W	270Ω 5W	LK2 position 2, LK3 out	+, 0, -
±20VDC	120Ω 1W	120Ω 1W	LK2 position 2, LK3 out	+, 0, -
±15VDC	10Ω 1/2W	10Ω 1/2W	LK2 position 2, LK3 out	+, 0, -
±12VDC	10Ω 1/2W	10Ω 1/2W	LK2 position 2, LK3 out	+, 0, -
43VAC	1.2kΩ 5W	1.2kΩ 5W	LK2 position 2, LK3 in	+, 0
40VAC	1kΩ 5W	1kΩ 5W	LK2 position 2, LK3 in	+, 0
35VAC	820Ω 5W	820Ω 5W	LK2 position 2, LK3 in	+, 0
30VAC	680Ω 5W	680Ω 5W	LK2 position 2, LK3 in	+, 0
28VAC	560Ω 5W	560Ω 5W	LK2 position 2, LK3 in	+, 0
25VAC	470Ω 5W	470Ω 5W	LK2 position 2, LK3 in	+, 0
20VAC	390Ω 5W	390Ω 5W	LK2 position 2, LK3 in	+, 0
18VAC	270Ω 5W	270Ω 5W	LK2 position 2, LK3 in	+, 0
15VAC	120Ω 1W	120Ω 1W	LK2 position 2, LK3 in	+, 0
11VAC	10Ω 1/2W	10Ω 1/2W	LK2 position 2, LK3 in	+, 0
+ 60VDC	1.2kΩ 5W	NA	LK2 positions 1&3, LK3 out	+, 0
+ 55VDC	1kΩ 5W	NA	LK2 positions 1&3, LK3 out	+, 0
+ 50VDC	820Ω 5W	NA	LK2 positions 1&3, LK3 out	+, 0
+ 45VDC	680Ω 5W	NA	LK2 positions 1&3, LK3 out	+, 0
+ 40VDC	560Ω 5W	NA	LK2 positions 1&3, LK3 out	+, 0
+ 35VDC	470Ω 5W	NA	LK2 positions 1&3, LK3 out	+, 0
+30VDC	390Ω 5W	NA	LK2 positions 1&3, LK3 out	+, 0
+25VDC	270Ω 5W	NA	LK2 positions 1&3, LK3 out	+, 0
+20VDC	120Ω 1W	NA	LK2 positions 1&3, LK3 out	+, 0
+15VDC	10Ω 1/2W	NA	LK2 positions 1&3, LK3 out	+, 0
+12VDC	10Ω 1/2W	NA	LK2 positions 1&3, LK3 out	+, 0

some of the coating from the pot bodies to get the solder to "take".

LED1 is installed by first bending its leads down through 90° exactly 8mm from its base. Make sure it is correctly orientated before you do this (see Fig.7). The LED is then installed so that it sits 6mm above the board, so that it will later protrude through its hole in the front panel.

The best way to do this is to cut a 6mm-wide cardboard spacer and push the LED's leads down onto this. Make sure that the LED goes in with its cathode towards switch S1.

Resistors R1 & R2 can now be installed but first, you have to choose the power supply to be used with the device. Table 4 shows the resistor values for the various supply voltages.

The links at LK2 and LK3 must also be selected according to the power supply. For a dual-rail (plus and minus supply), a jumper shunt is placed in position 2 for LK2, while LK3 is omitted. The supply leads are connected to the plus, 0V and minus supply inputs of CON1.

For an AC supply, a jumper shunt is placed in position 2 for LK2, while LK3 is fitted with a jumper shunt. The supply is connected to the plus and 0V inputs of CON1 or can be connected via power connector CON2.

Finally, for a single-rail DC supply, jumper shunts are placed in positions 1 & 3 of LK2, while LK3 is omitted. The supply can be fed in either via CON2 or the leads can be connected to the plus and 0V inputs of CON1.

Final assembly

The assembled PC board can now be installed in the plastic case.

Fig.10 shows the front and rear panel artworks and these can be used as drilling templates. They can either be copied or downloaded in PDF for-

Table 5: Choosing An Amplifier Module To Drive A 4-Ohm Hearing Loop

Power into 4Ω	Recommended Loop Size	Name	Issue	Kit Supplier
20W	3-8m square	Compact High Performance 12V Stereo Amplifier	May 2010	Jaycar KC5495, Altronics K5136
30W	2.5-11m square	Schoolies Amplifier	December 2004	Altronics K5116
55W	2-16m square	50W Audio Amplifier Module	March 1994	Jaycar KC5150, Altronics K5114
70W	2-18m square	SC480 Amplifier Module	January 2003	Altronics K5120
200W	1.5-33m square	Ultra-LD MK.2	August 2008	Jaycar KC5470, Altronics K5151
350W	Less than 42m square	Studio 350 Power Amplifier	January 2004	

This table lists several SILICON CHIP amplifier modules that are suitable for driving a 4Ω hearing loop. The recommended amplifier will provide the correct field strength 1.7m above or below the loop.

The final assembly involves attaching the front and rear panels to the PC board, then sliding it into position inside the case and installing four self-tapping screws into integral spacers.

mat from the SILICON CHIP website and printed out.

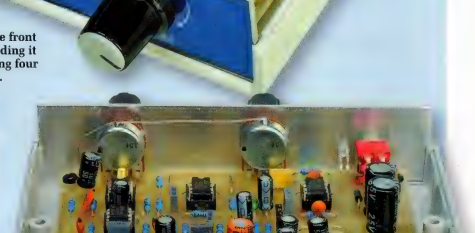
It's best to drill the holes using a small pilot drill and then carefully enlarge them to size using a tapered reamer.

Note that if you are using an XLR connector for the input, don't drill the holes for the left and right RCA sockets or the adjacent 6.35mm jack socket. Instead, you will have to mark out and drill a hole to accept the XLR socket.

The front and rear panel labels will be supplied if you purchase a kit. If not, download them from the SILICON CHIP website as described above. The file can then be printed out onto sticky-backed photo paper or onto plastic film (be sure to use the correct material for your printer). When using clear plastic film (overhead projector film), print the label as a mirror image so that the ink will be behind the film when it is affixed to the front panel.

Wait until the ink has thoroughly dried before cutting the label to size. It can then be affixed to the panel using an even smear of neutral cure silicone sealant. If you are affixing to a black coloured panel, use coloured silicone such as grey or white so the label has contrast. For panels that are off-white or are made of aluminium, the silicone can be clear.

Once the labels are in position, leave them overnight for the silicone to cure. The holes can then be cut out using a sharp hobby knife.



The rear panel provides access to the various input and output sockets, as well as to the power socket. Omit the power socket and fit a rubber grommet if you intend using a dual-rail supply (eg, derived from an amplifier).

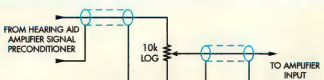


Fig.8: if the amplifier used to drive the loop lacks a volume control, you can add one yourself as shown here. Be sure to use shielded audio cable for the wiring connections.

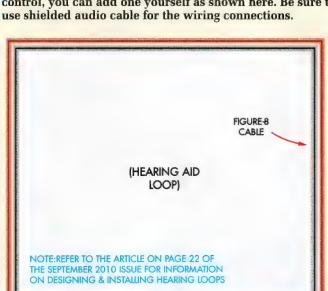


Fig.9: this diagram shows how to make a 2-turn hearing loop using figure-8 cable. Use heatshrink to insulate the link between the two loops. The remaining two terminals connect to the speaker output terminals of the amplifier.

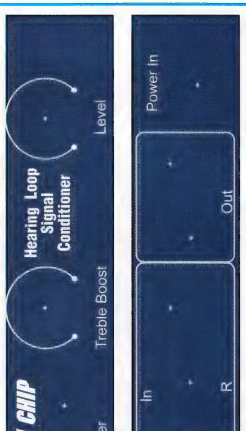


Fig.10: these full-size artworks can be used as drilling templates for the front and rear panels.

Once the panels are complete, fit them to the PC board by sliding them into position, then slide the entire assembly into the base of the case. The PC board is then secured to the base using four M3 x 6mm screws that go into integral mounting bushes. The assembly can then be completed by fitting the nuts to the pots, switch S1 and the 6.35mm jack sockets before fitting the two knobs.

Testing

To test the unit, first apply power and check that the power LED lights. If it does, the next step is to check the power supply voltages on the board (these will vary according to the supply used).

For a single-rail DC supply, the voltage between pins 8 & 4 of IC1 should be at about 15V, although this will be lower if the DC supply is below 15V. The same goes for IC2, IC3 & IC5. If this is correct, check the output voltages on pins 1 & 7 of IC1, IC2, IC3 & IC5. These should all be at about half supply, or about 7.5V for a 15V (or greater) DC power supply.

Now check the voltage on pin 13 of IC4. It should be at +15V but will be less than this if a lower supply voltage is used.

If you are using a dual-rail supply, the voltages should be measured with respect to the 0V rail. In this case, pin 8 of IC1, IC2, IC3 & IC5 should be at +15V, while pin 4 of each of these ICs should be at -15V. Once again, these voltages will be correspondingly lower if lower supply voltages are used.

Setting LK1 & LK4

Jumper link LK1 is required if a stereo signal is applied to the left and right RCA sockets or to the stereo 6.35mm jack socket. Conversely, leave LK1 out for a mono signal.

Note that a mono signal should be applied either to the left RCA input or to the tip connection of the 6.35mm jack input socket.

For a balanced XLR connection, use the separate input connections at pins 1 (ground), 2 & 3. In this case, link LK1 is not required and is left out (as are the RCA sockets and the 6.35mm stereo jack input socket).

Finally, link LK4 is fitted in the COMP position when signal compression is required and in the BYPASS position if compression is not required.

Signal levels

The Hearing Loop Signal Conditioner is designed to accept line level

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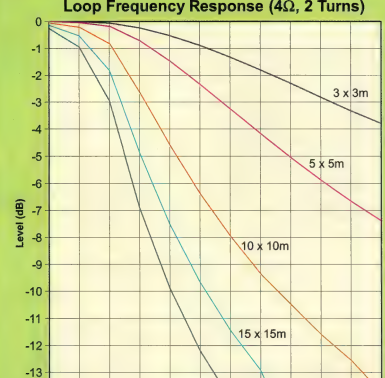

Fig.11: these curves plot the high-frequency roll-offs for several loop sizes ranging from 3 x 3m to 20 x 20m. The larger the loop size, the greater the inductance and the greater the high-frequency roll-off.

signals (ie, 774mV), while level control VR1 should be adjusted to provide satisfactory compressor operation. In practice, VR1 should be set so that there is an average of 1.8V between TP1 and 0V for a typical signal at the input (note: a "typical signal" is the program material that will normally be fed into the unit).

If TP1 is less than 1.8V with VR1 set to maximum, then the gain of the IC1a & IC1b amplifier stage will need to be increased. This involves reducing the 10kΩ resistor between pins 2 & pin 6 of IC1.

Final testing

Once the signal levels are correct, the unit can be tested by connecting it to an amplifier and feeding in a signal to drive the loop.

If the amplifier doesn't have a volume control, Fig.8 shows how one can be added. The amplifier's output connects to the 4Ω hearing loop and the volume control is used to set the overall level.

Fig.9 shows the way a figure-8 hearing loop is wired to the amplifier. The wire loops are effectively connected in series. Be sure to use heatshrink to insulate the link between the two loops.

The output from the pre-conditioner can be taken either from the RCA socket or from the 6.35mm jack socket. A suitable lead will be required to make the interconnection to the amplifier.

If the amplifier requires an XLR input, then a 6.35mm jack plug to XLR line plug lead can be made up. Pin 2 of the XLR connector is used to terminate the signal lead connection from the jack plug tip, while pins 1 & 3 are connected to ground via the jack plug's sleeve terminal.

Finally, VR3 (treble boost) can be adjusted. The Hearing Loop Tester described last month is used to check the loop frequency response. Adjust VR3 for a flat response to 5kHz. SC

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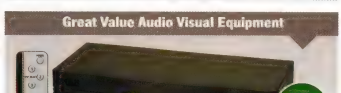

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Run out of HD inputs on your amp or TV? Take advantage of this handy 3 way component switcher. 1080i compatible. Also switches stereo RCA or optical audio with component video. Ideal for game consoles or DVD connection! **A 3071A**

SAVE $30
$99

Long Distance HDMI Sender

Send a full 1080i HDMI signal up to 55m over 2 lengths of Cat5e. Includes transmitter, receiver & plugpacks. 1080p 30m. **A 3216**

SAVE 17%
$19

Dynalink® 3 Way AV Expander

This tiny switcher provides 3 additional S-Video or stereo composite inputs. No power supply required! **A 3058**

SAVE 19%
$40

Dynalink® Digital TV Panel Antenna

Ideal for a home, boat or caravan! Provides 25dB gain for clear digital TV & radio reception. Includes power supply & PAL to F lead. Indoor or sheltered outdoor installation. Size 190x118mm. **L 2026**

NEW!
$34.95

TDK® Clip On Headphones

With Reverse Sound™ technology. Lets you listen to music & hear the environment around you. Great for exercising! **C 9010**

SAVE $40
$99

Volume Control With IR Repeater

Power an extra pair of speakers from your current amplifier. Rated at 30W per channel. IR repeater lets you control your AV system from the other room. **A 2309**

SAVE 22%
$39

Multiformat AV HDMI Wallplate

Back to back connection, no soldering required. Stereo audio, component video & HDMI connections. Fits a standard electrical wallbox. **P 6872**

SAVE $30
$139

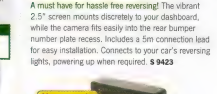
Install yourself & save!

120° view | 2.5" colour screen | Waterproof camera

Colour Reversing Camera & Monitor

A must have for hassle free reversing! The vibrant 2.5" screen mounts discretely to your dashboard, while the camera fits easily into the rear bumper number plate recess. Includes a 5m connection lead for easy installation. Connects to your car's reversing lights, powering up when required. **S 9423**

Hurry, stocks are limited!



SAVE $54
$75

Keyless RFID Entry for Home or Business

Uses coded tag keys and/or PIN to provide access to doors, gates etc. • 3 relay outputs • 12V operation • RFID tags sold separately $9.15 (S 5376), Credit card style tags $3.95 (S 5375). **S 5374**

SAVE 18%
$49

Record CCTV Footage To Your PC!

• Records 4 video channels & 2 audio channels to your hard drive. • Includes 'EZ-Cap' software • 704x576 recording resolution • Motion detect & schedule recording • MPEG4. **S 9479A**

ALTRONICS
ONE-STOP ELECTRONICS SHOP

3 Electronics Enthusiast Centres:

Perth WA: 174 Roe St
Auburn NSW: 15 Short St
Springvale VIC: 891 Princes Hwy

Power Problem Solvers

3A Multi Voltage Power Pack

Great for appliances with high current draw such as comms/IT equipment. Voltages: 5, 6, 7.5, 9, 12, 13.5, 15V. Output at 13.5 & 15V settings =2.4A. Includes mains lead. **M 8987A**

240V Mains Power Anywhere, Anytime!

This compact inverter generates mains power from your car battery. Suitable for use with laptops, TV's, battery chargers & stereos. • 150W, 450W surge rated. • Modified sine wave. • Host of protection features. • Soft start. **M 8072**

Ideal for the seldom used car, caravan or boat

Precision 6 Stage 12V Weatherproof Battery Charger

Utilises a microprocessor to ensure your battery is in tip-top condition whenever you need it. Diagnoses battery state of charge and delivers an appropriate current. • Helps to extend the usable lifetime of the battery. • Recovers batteries with slightly sulphated plates. • Suits SLA, wet cells, gel cell & AGM batteries. • 14.4V @ 6A max. • Size: 200 x 90 x 45mm. **M 8531**

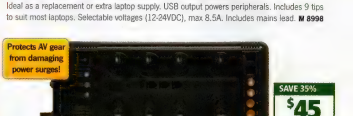
Operates down to -20°C	Suits permanent connection	Weatherproof case	3Ah to 200Ah

6/12V Hi-Capacity SLA Charger

Suits 6 or 12V batteries from 9 to 60Ah. With the latest in charge control ensuring long life from your batteries. Suitable for permanent connection. 2.7A charge current. **M 8528**

Laboratory Bench Power Supplies

The best power supplies we have ever tested! Features programmable preset outputs and adjustable current limiting. • Coarse/fine voltage & current adjustment • 5A aux output • Precision LED meters. Size: 200 x 90 x 215mm. **M 8221 1-15V 40A. M 8213 1-30V 20A.**



Powertran® 144W Laptop/Notebook Power Supply

Ideal as a replacement or extra laptop supply. USB output powers peripherals. Includes 9 tips to suit most laptops. Selectable voltages (12-24VDC), max 8.5A. Includes mains lead. **M 8998**

12V SLA Battery Charger

Suits 12V SLA batteries up to 7.2Ah. Easy to use, with trickle charging function to ensure long battery life. 300mA charge current. **M 8520**

Charge Up To 12 Batteries At Once!

10 x AA/AAA and 2 x 9V rechargeable overnight battery charger. Keeps plenty of batteries charged for the kids toys! Includes plugpack & car socket adaptor. **A 0276**

Energy Saving Power Board: Save Power, Save the Planet!

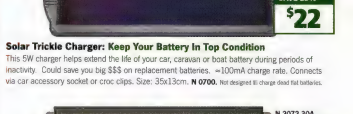
With power, telephone, aerial and sattelite dish surge protection. Allows a master appliance (ie TV) to switch on/off slave appliances automatically, such as receiver, DVD player etc. Drastically cuts standby power usage! **P 8170**

12V Auto Accessory Socket

Great for 4WD's, boats & caravans. Easy to build into cabinets. **P 0654**

Mini 12V Bulkhead Halogen Light

Ideal for installation in custom cabinets, boat cabins, caravans. Features on/off switch and adjustable light angle. Includes 10W MR11 globe. **X 2400**



Solar Trickle Charger: Keep Your Battery In Top Condition

This 5W charger helps extend the life of your car, caravan or boat battery during periods of inactivity. Could save you big $$$ on replacement batteries. ~100mA charge rate. Connects via car accessory socket or croc clips. Size: 35x13cm. **N 0700.** Not designed to charge dead flat batteries.

Solderless DC Power Jacks

A real time saver for CCTV installs & projects. Screw terminal connection 2.1mm. **P 0608 Plug. P 0610 Socket.**

MR16 5W LED Replacement Globes

Suitable for use with light dimmers! Provides >40,000 hours of life. Powered from a standard halogen transformer. 300 lumens, 40° beam. 10-15V DC or 12V AC operation. Note: Dimming works with iron core transformers.
X 2230 Cool White. X 2232 Warm White.

12V Photovoltaic Solar Charge Controllers

Ensures optimal battery charging cycles for both wet cells and sealed lead acid batteries. • Microprocessor controlled • Deep cycling for wet cells • Status screens showing panel & battery output • Over charge & over temp protection • Adjustable low voltage disconnect.

Express Order Hotlines:

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Fax: 1300 789 777
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Stock Up The Tool Box

SAVE $50

$179

Protek® TRUE RMS Datalogging DMM

The full house multimeter, packed with features and value! Excellent for research, design & service. Features:
• Dual display with bargraph
• Decibel capacitance, inductance & temperature • Alarm, clock & stop watch • Pulse signal injection • MIN, MAX, AVG & relative modes • Logic test • Continuity & diode test • Fused 20A input • Data hold & run mode.
Q 1098

USB PC Adaptor	Q 2340B	$29.95
Rubber Holster	Q 1093	$15.25

SAVE $20

$99

Water & Dustproof (IP67) True RMS Multimeter

Top of the range model. Ideal for marine & mining technicians. • True RMS measurement • 40MHz Frequency counter with bar graph • Max/min recording • Capacitance to 40mF. • Temp measurement • 10A current range • Auto power off • Includes thermocouple • Data hold.
Q 1068

$169 NEW MODEL!

Micron® 80W Digital Soldering Station

An excellent multi purpose soldering iron for service technicians, schools, engineers, R&D, production work etc. Japanese ceramic heating element for long life. 200° to 480°C. 0.8mm tip. **T 2418**

Suits lead free soldering	Silicon burn proof lead	All metal case

Super Value 19 Range DMM

With 1300°C temp probe and backlit display. Perfect for students, technicians & enthusiasts.
Q 1126

SAVE 25%

$22

Compact Autoranging DMM

Perfect for the home handyman or student. Features: • Backlit LCD • Temperature probe • Transistor & diode checker
Q 1130

SAVE 26%

$15

HDMI Lead Tester

Troubleshoot installs instantly. Tests patch leads or in-wall cabling. Provides indication of continuity & faulty wiring. Requires 9V battery. **Q 2030**

SAVE $14

$75

$329 SAVE $50

Backed by a full range of tips, filters & spares.

Micron® Precision Vacuum De-Soldering Station

Desolders ± 14 pin IC in under 30 seconds, even on double sided PCBs! Built tough to last a lifetime. Offering superb reliability, serviceability and performance, even when used every day! **T 1260**

Professional grade	300 to 450°C	High speed constant vacuum

REDUCED!

$19.95

Handy Cable Tacking Gun

Staples cable runs without damaging insulation. Suits pine or MDF. Cable size 4-8mmØ. Includes 100 staples. **T 2357**

Pk200 4-6mm Staples	T 2358	$9.95
Pk200 6-8mm Staples	T 2359	$9.95

SAVE 20%

$16

Pocket Rocket Blowtorch

One flick of the trigger and you have a whopping 1300°C flame ready for brazing or heatshrinking. Adjustable flame • One handed operation • Safety ignition lock • Refillable gas cartridge.
T 2490

SAVE 25%

$95

Locate the right cable in seconds!

Why spend hours tracking down data cables when this "cable sniffer" can find them in seconds? It also checks line polarity and voltage in network & telephone lines. Requires 2 x 9V batteries (S 4970 $2.50ea).
Q 1350

SAVE $20

$79

Whisk Away Fumes

Tired of coughing on soldering fumes when soldering? This compact fume extractor whisks away smoke & filters the air. All metal construction, built to last. **T 1295**

1000V Rated Insulated Screwdrivers

With rubberised grips & chrome vanadium tips. EN 60900 Approved. Includes 3 blade, 2 phillips & 240V tester. **T 2194**

SAVE 20%

$18

40pc Ratchet Service Kit

Includes metric sockets, slotted, hex, phillips, pozi and torx bits. Ratchet has a soft rubberised grip and variable angle head.
T 2168

SAVE 20%

$39

Combo Wire Stripper & Kwik Crimper

Combines a spring loaded ratchet wire stripper, cutting blade & kwik crimper in a single tool. Saves space in the toolbox! Suits 10-24 AWG cable. Crimps red, blue, yellow kwik connectors. **T 1528**

SAVE 26%

$22

SAVE 22%

$49

Sturdy Aluminium Tool Case

Aluminium panels, reinforced corners/seams for serious protection! Locking latches. 460x325x150 mm.
T 5020A

Tools not included.

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Auburn NSW: 15 Short St
Springvale VIC: 891 Princes Hwy

DIY Project Ideas...

Great for R&D!

NEW KIT!

$199

Dual Tracking 0-19V Power Supply Kit

(SC June '10) Delivers up to 1.6A from positive & negative outputs with a range of ±0-19V • Adjustable current limiting • Fixed 5V 750mA output for digital logic ICs and microcontrollers. • Low noise and ripple • Load regulation 0.1%. **K 3218**

$199 **$68.95**

Christmas Lighting Extravaganza Kits!

(SC October '10) Brings your christmas light show to life! Lights will flash, dim up & down in time with your favourite Christmas carols. Power up to 32 channels of lights from a master unit & 4 slaves. Each slave can run up to 2300W of lighting. Music input via SD card. Includes cases. **K 5885 Master. K 5886 Slave.**

Also great for shop displays, promotional events & interactive exhibits.

NEW KITS!

$14.95ea

Toslink S/PDIF Converter Kits

(SC October '10) Got a coaxial output but only an optical input? Or perhaps the other way around? No problem! These converter kits are the solution - plus they minimise hum on coax connections. Requires 6-15V AC or 9-20V DC plugpack. **K 5174 Toslink to S/PDIF. K 5175 S/PDIF to Toslink**

Includes waterproof case!

$198

NEW KIT!

Multifunction GPS Boat Navigator Kit

(SC October '10) Find your favourite fishing spot with ease. Super accurate realtime laptop navigation via USB - never get lost or disoriented on the water again!

Displays: • Speed • Heading • Fuel consumption

• Engine run time • GPS Coordinates • Clock. **K 1143**

More Recent Releases From Silicon Chip

Can be monitored using PC software.

NEW KIT!

$47.95

Intelligent Fan Controller Kit

(SC July '10). This compact module will regulate the speed of up to eight 12V fans. Measures up to 4 temperature points & smoothly controls fan speed. Ideal for computers, greenhouses, home breweries, amp cooling etc. **K 6120**

NEW KIT!

$28.95

Efficient Car/Motorbike USB Charger Kit

(SC May '10) Compact charging module for MP3 players, GPS devices & game consoles. • 89% efficiency • Very low quiesncent current will not flatten your battery • 12V input, 5V 525mA output. **K 1681**

Counts up or down from 1s to 100 hours in 1s steps

NEW KIT!

$87.95

Jumbo Display Remote Control Digital Timer Kit

(SC August '10) Switch low voltage devices on/off after set periods. Operated by the included A 1012 universal remote control. • Trigger inputs • DPDT relay output (30VDC/24VAC - not suitable for mains switching)

• Requires M 9237A 9V plugpack $17.95. **K 6145**

NEW KIT!

$38.95

Boost Dynamic Range From Your Microphone

(SC Sept '10) Mini Mic Pre-Amp Kit. Boosts signal levels for better volume from unpowered mics when used with a mixer or PC sound card. • Suits balanced or unbalanced mics • Low noise & distortion • Line level output.

• 5-20VDC input. **K 5514**

Works with regular headphones.

SAVE 12%

$34.95

Improve Your Hearing Without Expensive Aids!

(SC Sept '10) Hearing Loop Receiver Kit. Picks up signals from a hearing loop (or T-coil), found in PA systems at places of worship and function centres. It even works with home made hearing loops. Requires 9V battery (S 497) $5.95). **K 5547**

SAVE 10%

$79.95

Power Security & Shed Lights FREE from the Sun!

(SC May-Jun '10) MPPT Solar Light Controller Kit When coupled with a 5W solar panel (N 0005A $35) & 3.3Ah battery (S 5080 $29.80) this kit will power 10W of LED lamps for 2.5hrs a day. It accepts input from the included PIR movement detector, remote switch, or light sensor (for dusk switching). We suggest using with 3 x 3W star LEDs (Z 0259A $16.95ea.) **K 6028**

Sale Ends January 30th 2011

Altronics One-Stop Electronic Shops Phone 1300 797 007 Fax 1300 789 777

Mail Orders: C/- P.O. Box 8350 Perth Business Centre, W.A. 6849

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Resellers:

WESTERN AUSTRALIA		
Bunbury	ML Communications	9721 9800
Esperance	Esperance Communications	9071 3444
Geraldton	ML Communications	9965 7555
VICTORIA		
Alexandra	Alexandra Air Con & Appliance Centre	5772 1147
Ballan	Radcomp	5368 1761
Beaconsfield	Electronic Connections	9768 9420
Benalla	North East Electronics	5762 2710
Castlemaine	Top End Technology	5472 1700
Clayton	Rockby Electronics	9562 8559
Cranbourne	Bourne Electronics	5996 2755
Croydon	Truscott's Electronic World	9723 3860
Geelong	Academy TV Australia	5248 2527
Geelong	Music Workshop	5221 8844
Healesville	Amazon DVDs Healesville	5962 2763
Horsham	Leading Edge Electronics	5382 4150
Leongatha	Gardner Electronics	5662 3866
Melton	Melton Electronics & Communications	9743 1233
Nunawading	Semtronics	9873 3555
Pakenham	Get Smart Hifi	5941 4886
Preston	Preston Electronics	9484 0191
San Remo	Shoreiec Electrical Wholesalers	5678 5361
Somerville	AV2PC	5978 0007
Swan Hill	Lateral Communications	5032 2322
Warrnambool	Koroit St Electronics	5561 5111
Wodonga	Exact Computers & Home Ent.	6056 5746
QUEENSLAND		
Airlie Beach	Plaza Electronics	4946 6550
Brisbane South	Delsound	3397 8155
Brisbane North	Prime Electronics	3262 7466
Capalaba	Diggy Technology	3245 0000
Cairns	Pentacom	4032 1710
Cloncurry	Access Electronics	4742 2590
Dalby	Camera House	4662 3233
Gold Coast	Prime Electronics	5531 2599
Hervey Bay	Leading Edge Electronics	4124 1490
Innisfail	Leading Edge Electronics	4061 6214
Kingaroy	SB Computers	4160 4800
Longreach	Access Electronics	4658 0500
Maryborough	Leading Edge Electronics	4121 4559
Mossman	Leading Edge Electronics	4098 2200
Rockhampton North	Home Delivered Computers	4926 2555
Rockhampton South	Access Electronics	4922 1058
Toowoomba	Michael's Electronics	4632 9990
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Yeppoon	Keppel Electronics	4939 1555
NEW SOUTH WALES		
Brookvale	Brookvale Electrical Distributors	9938 4299
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Cessnock	Leading Edge Electronics	4990 5971
Cobar	Cobar Electronics	6836 2962
Denilliquin	Wired Entertainment	5881 3555
Gloucester	Autolec Gloucester	6558 1600
Grafton	Downes Electronics	6642 1911
Griffith	Griffith Systems Plus	6964 9883
Gunnedah	Protronics	6742 2110
Lithgow	Leading Edge Electronics	6352 3333
Mudgee	Home & Office Electronics	6372 1822
Port Richmond	CPT-Candle Power Technologies	4571 4699
Oak Flats	Oak Flats Electronics	4256 6120
Orange	Forday Electronics	6362 9901
Penrith	Penrith Light and Sound	4733 3333
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Raymond Terrace	Leading Edge Electronics	4987 4909
Smithfield	Chantronics	9609 7218
Tamworth	Bourne Street Electronics	6766 4664
Taree	Noeledge Systems Pty Ltd	6551 3622
Ulladulla	Leading Edge Electronics	4454 5588
Wagga Wagga	Wagga Car Radio & Hi-Fi Pty Ltd	6925 6111
Waterloo	Herkes Electrical Supplies	9319 3133
Wetherill Park	Techtron Electronics Pty Ltd	9604 9710
Windaroo	Med Electronics	4297 7979
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Mt Barker	Force Electronics	8391 1133
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PRODUCT SHOWCASE

element14 has latest AC/DC LED solutions from RECOM

element14, formerly known as Farnell, has added a new range of high-efficiency RECOM power solutions. These are constant current LED drivers in the power range of 12 and 20W.

The drivers are designed to be simple to use without an extensive knowledge of electronics and offer both input and output screw terminals and an additional 5.5mm socket output. The socket allows the LEDs to be pre-wired with a matching plug to avoid possible miswiring and make lighting installation easier and safer.

With over 70,000 hours of operating life, they are ideal for commercial, residential and industrial lighting systems. The RACD12 Drivers are compatible with all CREE LED MPLs and RACD20 Drivers work for up to 15 x 1 Watt LEDs.

There are no minimum order quantities or values and element14 offer next day delivery, 24/7 customer service telephone support and 24/5 online technical support in local languages.

Contact:
element14
72 Ferndell St, Chester Hill NSW 2162
Tel: 1300 361 005 **Fax:** 1300 361 225
Website (Aus): http://au.element14.com
(NZ): http://nz.element14.com

ProtoGEAR development gear

If you're building any sort of prototype electronic gear or project, be sure to stop in and see what ProtoGEAR have to offer. They offer a broad spectrum of gear ranging from breakout boards for SMD chips to development platforms for microcontrollers.

One of the more difficult things when you're trying to test a concept is constructing hardware for a one-off, especially if it involves SMD chips.

Breakout boards are small PC boards with a footprint for the chip, with the legs routed out to through-hole pads, and are normally laid out with a DIP footprint. From there, you can solder wires or header pins to them and insert them into a breadboard or whatever you like.

They offer bare breakout boards in a variety of footprints and sizes for generic use.

Also on offer are more specialised breakout boards for chips such as FTDI's FT232RL, the USB to serial converter chip. The specialised versions have all components populated and are ready to be used in your next project.

Contact:
ProtoGEAR
Tel: Phone: 1300 456 820
Website: www.protogear.com.au

Handheld cable and antenna analyser from Rohde & Schwarz

The new R&S ZVH handheld analyser from Rohde & Schwarz was designed especially to meet the high time and cost pressure demands in setting up mobile radio antennas and base stations.

Two frequency ranges, from 300kHz to 3.6GHz or 8GHz, are provided to help network operators, infrastructure manufacturers and their service providers install and maintain mobile radio antennas with a minimum of effort and time.

The RF characteristics of the R&S ZVH make it one of the best analysers in its class. It is the only cable and antenna analyser on the market with a dynamic range of 100dB, easily fulfilling the manufacturers' guidelines of > 90dB required for repeater measurements.

The cost-effective handheld analyzer replaces conventional test setups consisting of a signal generator and a spectrum analyser. The built-in DC bias supplies power to active DUTs, such as amplifiers, at both test ports via the RF cable. This function is especially useful for tower-mounted amplifiers (TMA).

The R&S ZVH is 194 × 300 × 69mm and weighs just 3kg. It comes with options for spectrum and network analysis and spectrogram display which cover applications such as spectrum analysis, field strength measurements, signal monitoring and interference hunting. Using external power sensors, the R&S ZVH can also operate as a power meter. When used with a directional power sensor, the analyser can simultaneously measure antenna matching and transmitter output power up to 300W.

Contact:
Rohde & Schwarz (Aust) Pty Ltd
Unit 2, 75 Epping Rd, North Ryde NSW 2113
Tel: (02) 8874 5111 **Fax:** (02) 8874 5199
Website: www.rohde-schwarz.com.au

Mikrotik 5 Port Ethernet Router

The powerful, new, low-cost Mikrotik RB750 is a compact, 5 port Ethernet router running Mikrotik RouterOS, a stand-alone operating system based on the linux kernel.

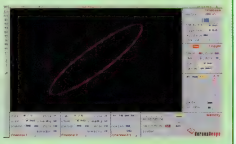
This router is probably the most affordable and configurable 5-port managed switch/router available.

It has loads of features including Multi Protocol Label Switching (MPLS), static and dynamic routing, packet filtering firewall, bandwidth management, VPN server with various VPN methods and tunnelling protocols, Quality of Service (QOS) to prioritise and shape network traffic, along with a large number of network tools all with an easy to use GUI or command line interface.

The RB750 sells for $89.95

Contact:
WiFi Products
Unit 2, 24 Windorah St, Stafford, Qld 4053
Tel: (07) 3356 0688
Website: www.wifiproducts.com.au

XY mode for Screenscope



Screenscope now supports the XY mode function where channel 1 is plotted against channel 2.

The drawing is done at the hardware level with dot joining to give fast real time performance.

Unlike on an analog scope the other channels can also be displayed at the same time allowing easier setting up and triggering for best displayed waveform.

The screenshot shows the trace doing several circuits of a rotating lissajou figure from the comparison of two sine waves. XY mode is also useful for parametric measurements and studying dynamical systems.

Screescope's measurement markers can also be used on the XY trace to directly read the voltage values at any point in both X and Y directions.

XY mode is available to existing users as a flash download.

Contact:
ScreenScope
PO Box 105 Hurstbridge 3099
Tel: (03) 9714 8597
Website: www.screenscopetraces.com

Fracarro Digital-optimised Log-Periodic TV Antennas from WES

With the deadline for digital TV now being measured in months, WES Components is offering a range of Italian made "Fracarro" log-periodic antenna which have a uni-directional, narrow-beam antenna that has impedance and radiation characteristics best suited for digital TV (DVB-T).

Typical of log periodics, they are highly directional with low return losses and cover the VHF/UHF digital and analog bands (VHF 174-230MHz/UHF 470-862MHz which includes the entire bands 3, 4 and 5; Australian channels 6 – 69) and can be mounted to suit both horizontal and vertical polarisation.

With a maximum gain of 9dBi/11dBi (VHF/UHF) and front-to-back ratio or 24dB/32dB they have a return loss of -13dB/-13dB and a beamwidth (-3dB) ±34°/±31°.

The highly-reliable Fracarro antennas use a balance of precision design & technology with quality materials to produce a superior product. It's the only one that carries the distinctive FR trademark and the first true Log Periodic antenna for DVB-T.

Contact:
WES Components
138 Liverpool Rd, Ashfield NSW 2131
Tel: (02) 9797 9866 **Fax:** (02) 9716 6015
Website: www.wes.net.au

ecoswitch uses your existing powerboard to switch off standby!

With the cost of electricity now way past the roof and heading towards the stratosphere, here's one of those "why didn't someone think of it earlier?" ideas.

It's the ecoswitch – a finalist in the 2007 ABCTV "New Inventors" program and 2009 "Next Big Thing" awards.

It's simply an extension switch which you mount in a handy position (saves having to reach behind furniture!) and connect it (in series) to your existing mains powerboard.

Then you can turn off all those wasteful "Standby" devices which are costing you possibly hundreds of dollars over the course of a year. (ecoswitch claim it will save the average household over $120 per year with just three devices).

It's a passive device so it is not going to cost you anything to use.

Contact:
Carbon Reduction Industries Pty Ltd
PO Box 79, Marysville Vic 3779
Tel: (03) 5963 7253
Website: www.eco-switch.com.au

Vintage Radio

By RODNEY CHAMPNESS, VK3UG

Portable HF transceivers used by the Forests Commission of Victoria

The Forests Commission of Victoria (FCV) was in charge of Victoria's state forests from 1918 up until 1983. During that period, it used a range of interesting portable HF transceivers. We take a look at some of these sets here.

IN CASE YOU'RE wondering what happened to the Forests Commission of Victoria, it subsequently became part of the Department of Sustainability and the Environment (DSE). Today, the communications facilities available to the DSE are vastly superior to those that were available to the FCV, especially prior to WWII. The equipment now used by the DSE include a range of VHF and UHF 2-way radios (both analog and digital), plus the necessary hill and mountain-top repeater stations to maintain communications in difficult terrain.

In addition, some services use satellite phones, mobile phones and UHF CB radios as necessary in emergency situations.

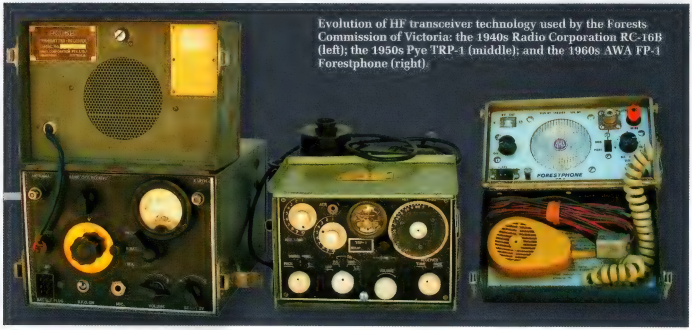
The era before WWII

In the years before WWII, telephones were uncommon in many of the remote and often mountainous areas administered by the FCV. This meant that radio transceivers were necessary to provide effective communication links during routine work. They also proved vital for coordinating efforts during bushfire emergencies.

Many of the radios used were sourced direct from the manufacturers but quite a few were actually built by employees of the FCV. Just how the FCV went about establishing their radio network in the 1930s and early 1940s has largely been lost with time, something that happens all too often when government departments reorganise themselves and historical documents are destroyed.

However, much is known about the equipment installed by the FCV and the transmitters and receivers used.

Over the years, the FCV installed base radio stations at locations where access to utilities such as mains power, telephone and postal facilities were generally available, eg, in country



Evolution of HF transceiver technology used by the Forests Commission of Victoria: the 1940s Radio Corporation RC-16B (left); the 1950s Pye TRP-1 (middle); and the 1960s AWA FP-1 Forestphone (right).

towns. The transmitters used were often made by the FCV and a number of them used the rather large 813 transmitting valve.

These AM transmitters were grid modulated, with an output power of around 50W. These were quite large at around 1.5m high and about 50 x 50cm square.

A variety of receivers were used, many of which were ex-service items such as the Kingsley AR7. The antenna systems were usually horizontal dipoles strung between long thin wooden poles harvested from the forests that the FCV administered.

Frequencies in the higher MF and lower HF ranges were typically used for local communications. In earlier times, frequencies in the 3MHz and 4MHz range were used as the RC16B (for example) did not tune below 3MHz. By contrast, frequencies between 2600kHz and 2800kHz were used in the later days of the FCV's involvement with HF radio. However, the base stations used higher frequencies to communicate with other base stations during emergency situations.

Portable HF transceivers

Transceivers were expensive to produce in the immediate pre-war and post-war years. They were also bulky, heavy and nowhere near as effective as communications equipment is today.

Prior to WWII, the equipment was made as simple as possible to keep costs down. As can be imagined, by comparison with today's gear, it was quite primitive. Let's take a closer look at some of the early transceivers used by the FCV, beginning with the Radio Corporation RC16B.

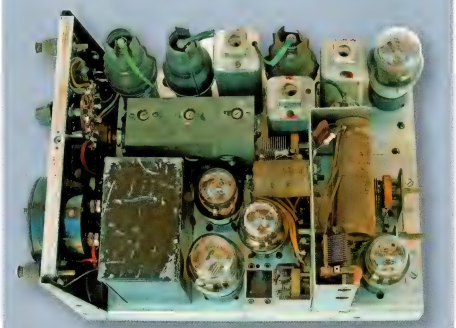
Radio Corporation RC16B

The RC16 high-frequency transceiver (and the military version the ATR4A/B) was designed and built by Radio Corporation in 1939, just before the outbreak of WWII. The receiver covered the 3-7MHz band and was a conventional superhet intended for AM reception. It also had provision for the reception of Morse code.

The transmitter section had an output of between 1.5W and 2W on either AM or CW (Morse code).

This transceiver was initially designed as a commercial portable unit and was designated the RC-16. A subsequent modified version intended for military use was designated the RC16B or ATR4A/B. The FCV adopted the RC16B for its work, as did a number of other forestry organisations throughout Australia.

The Radio Corporation RC16B covered the 3-7MHz band. It featured a 4-valve superhet receiver section, while the transmitter stage had an output of 1.5-2W and could transmit either AM or CW (Morse code).



This above-chassis view of the RC16B shows how tightly the parts were packed in, to minimise cabinet size.

Basically, the receiver used in the RC16B is a 4-valve superheterodyne unit which tuned from 3-7MHz in one band. To assist tuning, a 6:1 reduction vernier drive is used. The dial calibrations are rather sparse, so it was necessary to tune with care across that segment of the band where transmissions were expected.

Basically, it was necessary to hear the transmission before being sure that the receiver was tuned to the correct frequency. There was no provision for "netting" the receiver to the transmitter. However, the receiver does have one redeeming feature with its tuning, in that once a station has been tuned, it could be locked to that frequency.

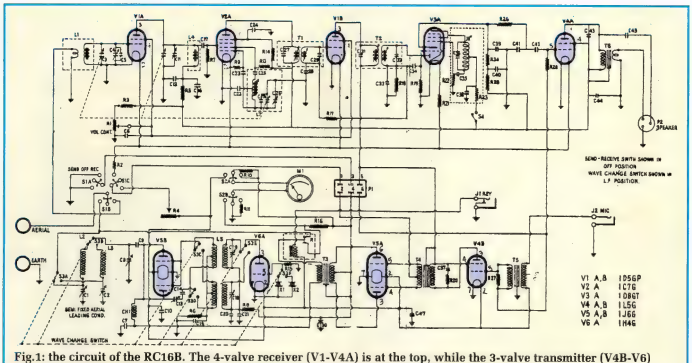
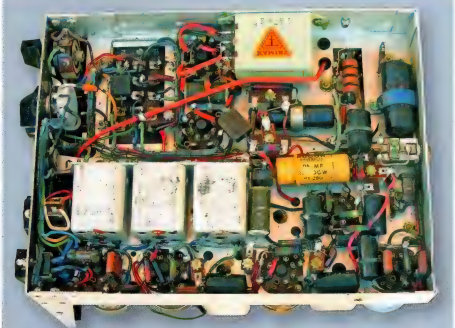


Fig.1: the circuit of the RC16B. The 4-valve receiver (V1-V4A) is at the top, while the 3-valve transmitter (V4B-V6) stage is along the bottom. V4B & V4A form the modulator, V6 is the RF oscillator and V5B is the power amplifier.



The parts under the chassis of the RC16B are neatly laid out, with short leads and laced cable looms to ensure reliability.

By the way, for those readers unfamiliar with the term "netting", it involves operating a low-level stage of the transmitter while tuning the receiver to the transmitter's frequency.

The first stage of the receiver is a tuned radio frequency (RF) amplifier using a 1D5GP pentode (V1A). This feeds a 1C7G frequency converter (V2A) and the 455kHz IF (intermediate frequency) on the plate of this stage is applied via the first IF transformer to another 1D5GP (V1B) which functions as an IF amplifier. The signal is then applied via the second IF transformer to the diode detector in V3a, a 1D8GT diode-triode-pentode valve.

The volume from the RC16B is controlled by varying the screen voltage on the RF and IF amplifier stages (V1A & V1B). This is effective although it's strange that automatic gain control (AGC) was not used, as the RF amplifying valves are variable cut-off types.

Following the detector, the audio is fed to the triode stage in V3A and the amplified signal then fed to a 1L5G output valve (V4A). This then drives the loudspeaker via transformer T6.

Morse reception

The pentode section of the 1D8GT (V3A) is used as a beat frequency oscillator (BFO) for Morse code reception. For those unfamiliar with the use of a BFO, it provides a low-level signal that's close to the frequency of the received Morse signal. These two signals then beat together to give an audio output which can then be read by a skilled Morse operator.

No provision was made for the use of headphones, despite the fact that these would have made copying of Morse code signals easier.

In use, the front lid hinged up to reveal the speaker grill (see photograph). The microphone and antenna lead were normally stored behind this panel when it was not being used.

All the valves in the receiver are 2V filament types, with the exception of the 1D8GT which is a 1.4V type. Perhaps the original RC16 had a 1H6G as the detector and first audio stage and the BFO was not included as it was not

required for normal AM communications. In fact, the Morse code function was probably an "add-on" for the military. The addition of Morse code (CW) to the transmitter stage also has the appearance of being an add-on but more on that later.

Transmitter circuit

The transmitter section uses four valves, all being 2V filament types. The RF oscillator uses a 1H4G (V6A) valve and has switching for two frequency bands – either 3-4.8MHz or 4.8-7MHz. The wave-change switch selects the various tuned circuits and switches in either crystal X1 (3-4.8MHz) or crystal X2 (4.8-7MHz) to control the oscillator frequency.

The output from the 1H4G is passed via tuned circuits to a power amplifier (PA) stage based on V5B, a 1J6G (V5B) twin-triode with both sections wired in parallel. The amplified signal from the 1J6G is then fed through another tuned circuit to the antenna.

Either the supplied 15m-long wire antenna or a horizontal Windom-style antenna can be used. Note that the PA stage is operated with both its input and the output on the same frequency. As a result, this stage is neutralised to prevent it from becoming unstable and going into uncontrolled oscillation.

The modulator is quite conventional and is rather like the audio output stage of a battery-powered domestic radio of the late 1930s. Basically, the audio signal from the carbon microphone is amplified in a 1L5G (V4B). This in turn feeds an audio driver transformer which has a push-pull output winding. The resulting push-pull audio signal is then applied to the grids of V5A (1J6G).

Finally, V5A applies audio to the PA stage via modulation transformer T3. The 1J6G modulator can be run with little or no bias but Radio Corporation decided to use a reasonable amount of bias to ensure that the valve did not draw too much current.

Transmitter Morse code

As stated, the provision of Morse code in the transmitter appears to be something of an afterthought. For normal AM operation, the Morse key is not plugged in and as a result, the small relay shown just to the upper right of the transmitter oscillator is normally in the operated position.

The Pye TRP-1 superseded the RC-16B and was both smaller and lighter than its predecessor while offering superior performance. The transmitter output power was the same as the RC-16B at around 1.5-2W.

In this condition, all is normal for voice/AM operation of the transmitter. However, when the Morse key is inserted (but not pressed) the relay drops out, the antenna is shorted to chassis at RF (on transmit) and the HT (high-tension) voltage is removed from the PA stage.

When the Morse key is subsequently pressed, the antenna RF short is removed and HT is re-applied via the secondary of T3 to the PA. During this time, the modulator stages remain in operation, which is unnecessary and just uses some of the limited power. It is not good practice to key the transmitter via the HT lead that goes through the modulator transformer and good designs do not do this.

Filament power for the transmitter is supplied from a 3V battery, while a series rheostat allows the filament voltage to be adjusted to 2V. This voltage, the HT voltage and the PA current are all monitored via a switched meter on the front panel.

Although this transceiver was quite effective for its time, the battery drain was quite high. The unit consumed around 4W of power on receive and 12W on transmit. The weight of all the equipment packs was around 19kg.

As an aside, the RC16 was similar in many ways to many of the Traeger pedal radios of the late 1930s.

Pye TRP-1

Low-current miniature valves became widely available after the war. As a result, Pye-Electronic Pty Ltd (which had taken over Radio Corporation) decided to design a transceiver to replace the RC16B. Designated the TRP-1, it was considerably lighter and used less power than the RC16B while offering similar or better performance.

The TRP-1 had a tuning range of 2.7-7MHz, which is slightly wider than the tuning range of the RC16B. It was quickly taken up by the FCV and proved popular due to its lighter weight, slightly greater transmitter power and wider frequency range. It could also be used as a walkie-talkie and the ability to crystal lock the receiver to a frequency made it quite popular – even more so than its predecessor.

The TRP-1 is built on a conventional chassis and consumes around 2.6W

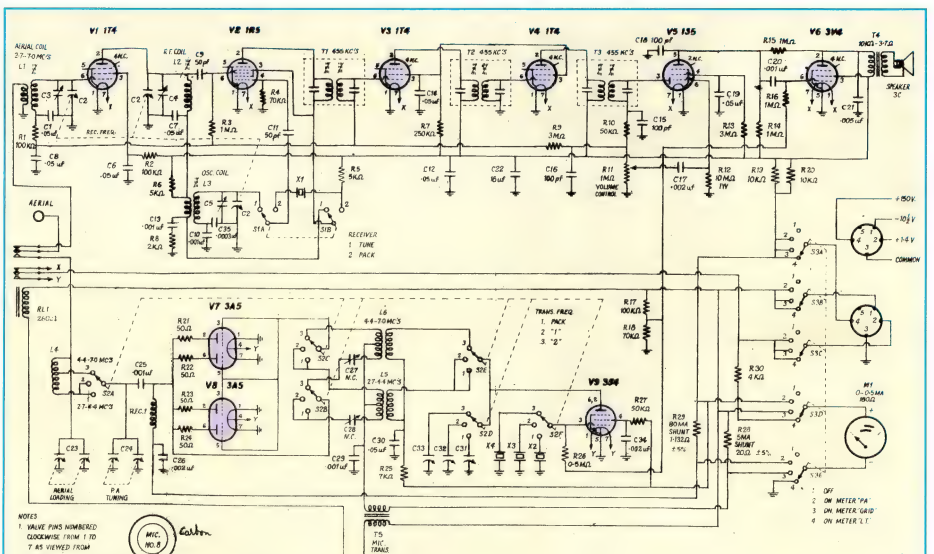


Fig.2: the TRP1 uses a 6-valve (V1-V6) superhet receiver stage. V1 (1T4) is the RF stage, V2 (1R5) is the converter, V3 & V4 (1T4) are the IF amplifiers, V5 (1S5) is the detector/AGC/audio amplifier and V6 (3V4) is the audio output stage. The transmitter stage uses V9 (3S4) as the crystal oscillator, while V7 & V8 (3A5) form the RF output stage.

on receive and 9W on transmit. It was designed to be used either as a semi-fixed portable or as a true portable transceiver. As a walkie-talkie station, it weighs 9.5kg. The portable battery weighs 3.6kg while the "camp" battery (for fixed station use) weighs in at a massive 16.7kg.

Fig.2 shows the circuit details of the set. The receiver (V1-V6) is a conventional superhet with a 1T4 RF stage, a 1R5 converter, a 2-stage IF amplifier using 1T4 valves, a 1S5 detector/AGC/audio amplifier and a 3V4 audio output stage. The -4V bias for the 3V4 is derived from a -10.5V bias battery within the battery pack.

A 150V battery provides the HT (high tension) for the receiver. This is supplied via resistors which drop the applied HT voltage to around 75V when the receiver is operating.

The RF, converter and first IF stages all have simple AGC applied to them. The converter can either be manually tuned across the 2.7-7MHz band or tuned to a spot frequency using its crystal oscillator.

The transmitter stage uses a 3S4 (V9) which operates as a crystal oscillator-cum-driver for the output stage. It has -4V of bias applied to protect the valve in the event that crystals are not fitted in all three crystal positions.

The RF output stage consists of two 3A5 valves (V7 & V8) with all sections connected in parallel. Each plate has a 50Ω "parasitic stopper" in it to prevent the unit from transmitting spurious signals. With four triodes connected in parallel, it is mandatory to have a neutralising circuit.

The output circuit is manually tuned and the circuit loaded for best output on each transmission frequency selected.

The modulator is the essence of simplicity compared to most other modulators. Modulation is achieved by feeding the output from a carbon microphone to transformer T5 and then to the grids of the 3A5 valves, with -10.5V of bias.

The changeover from receive to transmit is accomplished by pressing the PTT (press-to-talk) button on the microphone. This grounds one side of the change-over relay which then swaps the antenna from the receiver to the transmitter, disconnects the receiver filaments and applies 1.5V to the transmitter filaments. The HT is left on at all times in both the transmitter and the receiver, so it is imperative that no work is done on either the transmitter or receiver with the set turned on.

The above-chassis (top) and under-chassis (bottom) views of the Pye TRP-1 HF transceiver. This set uses miniature valves and the parts are all easy to access for service.

The AWA FP-1 (Forestphone)

In the mid 1960s, AWA was asked to design a solid-state replacement for the TRP-1 in collaboration with the FCV. The new transceiver was to be more powerful than the TRP-1, with an output power of about 10-12W (compared to 1.5-2W).

The set also had to be capable of being used as a walkie-talkie, as well as being suitable for use in a vehicle.

The solid-state AWA FP-1 Forestphone replaced the TRP-1. It was smaller and featured a more powerful transmitter, with an output power of 10-12W.

In addition, the FCV wanted to be able to remove it from a vehicle mount and convert it to walkie-talkie or base station operation in a matter of minutes.

Some of the features of the earlier transceivers were found to be redundant. It was unusual to need more than one frequency, so the receiver and transmitter were both crystal-controlled to work on a single frequency. However, a (rare) variant designated the FP-5 had outriggers on each side of the transceiver which enclosed switching for a total of five crystal-locked channels.

Having the tuning preset made the set easier to use for the average non-technical forestry worker.

Because it could be used in different configurations (a walkie-talkie, a portable, a mobile or a base station) at short notice, provision was made for several antennas with different characteristics. Over the years, the range of frequencies used became consolidated in the 2-5MHz range, where communication was found to most be most reliable.

The red-capped antenna terminal is connected to a 600Ω tap on the toroidal matching transformer in the output of the transmitter stage. The FCV used Windom-type antennas at many of their HF base stations and the nominal impedance of the single wire feed to this antenna is around 600Ω. The coaxial antenna connector is connected by a slide switch to two taps on the output transformer, giving an impedance of 50Ω which suits most mobile antennas and an impedance of 200Ω for much less efficient portable or walkie-talkie type antennas.

The receiver is a conventional short-wave unit for the late 1960s and uses one NPN and 10 PNP germanium transistors. This section is built on three PC boards, one for the RF amplifier and mixer, another for the IF amplifier, detector and noise limiter and the third for the low-level audio stages.

The front end of the receiver has an RF amplifier followed by the mixer and a separate crystal oscillator. The output of the mixer is then amplified by the 2-stage IF section and applied to the detector and a noise limiter diode. The noise limiter diode was necessary to prevent ignition noise when the transceiver was used in vehicles.

The DC voltage developed at the detector is applied to a transistor which acts as both an audio preamplifier and an AGC amplifier. The resulting AGC voltage is amplified by another two DC-coupled transistors and applied to the RF amplifier and the IF amplifier stages.

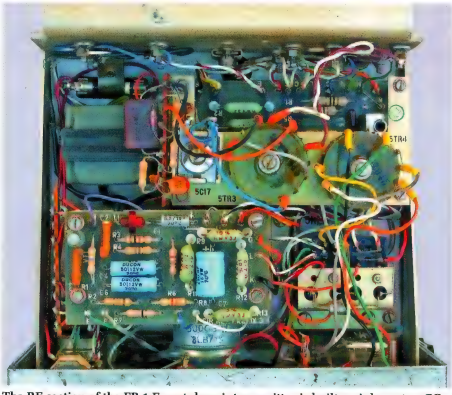
The audio is applied via a volume control to a 2-stage audio amplifier and finally to the loudspeaker. As a space (and cost) saving measure, this stage is also used as part of the transmitter modulator, by switching the input to a dynamic microphone instead of the audio preamplifier.

The audio output transformer has one centre-tapped primary winding and two secondaries. One secondary is switched to the loudspeaker, while the other secondary is centre-tapped and drives the bases of the two 2N301A modulator transistors.

The RF section of the transmitter is mainly built on two PC boards, with the larger electronic components mounted on the chassis or other sub assemblies. The crystal oscillator and its buffer amplifier use two transistors (VT1 & VT2). Its output is fed to an RF transformer which then drives two 2N3879 transistors arranged in push-pull configuration in the power amplifier (PA) stage. Each of these transistors is neutralised to ensure RF stability.

As mentioned earlier, the modulator shares most of the receiver's audio circuitry. This drives two 2N301A modulator transistors in push-pull. The output winding on the modulation transformer has several taps so that a small amount of modulation is applied to the RF driver stage and full modulation to the PA stage.

The output stage tuned circuit consists of a toroid with a centre-tapped primary and a secondary with 11 taps, so that the correct amount of induct-



The RF section of the FP-1 Forestphone's transmitter is built mainly on two PC boards, with the larger electronic components mounted on the chassis or other sub-assemblies. As a space-saving measure, the modulator shares most of the receiver's audio circuitry (not visible here).

ance can be selected for a particular frequency. This is then fine-tuned by adjustable trimmer capacitors. This stage is then coupled across to an antenna matching/tuning circuit that's identical to the PA tuned circuit.

Switching between receive and transmit is achieved by a PTT switch on the microphone. This actuates two relays to change from one function to the other.

An important feature of the set is that its DC supply rails are isolated from the chassis, so that it can cope with both negative-earth and positive earth vehicles (both types were produced at the time). In addition, the set features reverse polarity protection and is fused to provide protection if a fault develops.

The RF output from the Forestphone is about 10-12W with a 12V DC supply and this increases to around 15W with a 13.8V DC supply. Its current drain is 20mA on receive with no audio output, 2A with the transmitter operating but with no modulation and up to 3.8A with full modulation. The receiver's sensitivity is better than 2µV (using AWA's test procedure), which is noticeably better than the sensitivity of either the TRP-1 or the RC16B.

The FP-1 is lighter than either of the two previous units. It weighs 3.7kg complete with its front storage cover and vehicle mount rack but this does not include the weight of any antenna equipment. For portable or walkie-talkie use, it is necessary to add another 3-5kg for a sealed 12V battery.

Summary

The period of portable HF transceivers in the Forests Commission of Victoria extended from around 1939 through to the mid-1970s, when VHF radio communications took over. The evolution of the sets in size, receiver sensitivity, transmitter power and ease of operation demonstrate how HF transceivers developed in era before VHF radio systems came of age. SC

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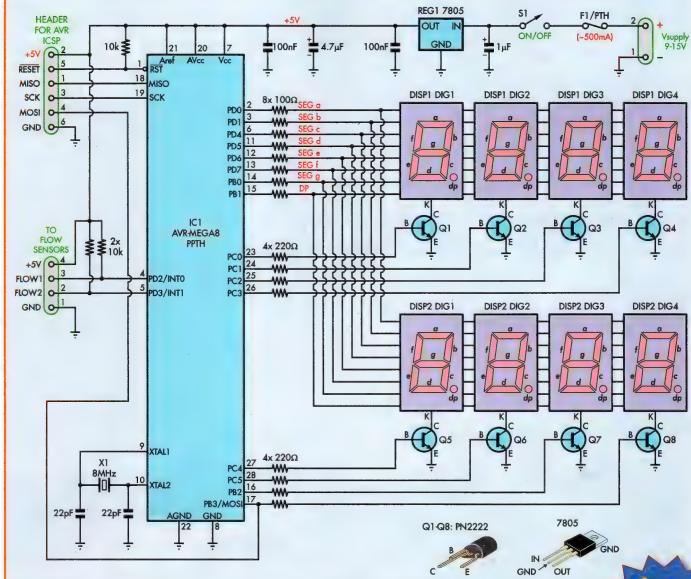
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Fuel flow meter for diesel engines

The easiest way to measure fuel flow to an engine (for calculating fuel economy, etc) is to monitor the average pulse width of the fuel injectors. However, this doesn't work for diesel engines with mechanical fuel injectors.

In this case, it is necessary to use a flow sensor. This is not as straightforward as it seems because the fuel pump runs continuously, keeping the fuel supply to the engine at a constant pressure. Any fuel that is not burned in the engine is fed back to the tank by a return pipe. As a result, it is impossible to know how much fuel is being burned by measuring just the flow between the fuel pump and the engine.

The solution is to use two flow sensors, one to measure the fuel flowing to the engine (the "inlet" sensor) and one to measure the fuel flowing back (the "return" sensor). By calculating the difference, the actual amount of fuel burned can be determined.

There are some challenges to implementing such a scheme. At low RPM, the difference in flow rates is small so the readings must be very accurate. To make matters worse, the data from the return sensor at low RPM can be quite erratic (see graph) and must be time-averaged in order to get an accurate result.

This circuit solves those problems. It is built around an ATMega8 microcontroller (IC1). The two flow

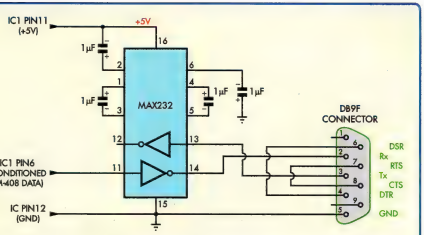
Craig Polley is this month's winner of a Peak Atlas Test Instrument

NMEA interface for EM-408 GPS module

The GPS Boat Computer described in the October 2010 issue of SILICON CHIP can be considerably enhanced if the signal from the EM-408 GPS module is passed to a chart plotter or to a DSC-equipped VHF transceiver.

For example, the GME GX600D VHF Transceiver recognises GLL, GGA, RMC GNSS GPS sentences. (NMEA stands for National Marine Electronics Association).

The EM-408 GPS module in the boat computer circuit operates in NMEA 0183 mode and outputs ASCII messages in GGA, GSA, GSV and RMC at 4800 baud. In practice, this only requires a simple interface which can employ a MAX232 RS-232 driver. This connects to a DB9F connector and may be assembled on a piece of Veroboard.



Geoffrey Graham, Kensington, WA. ($40)

sensors, with open collector outputs, are connected to inputs INT0 and INT1 (pins 4 and 5). Two 10kΩ pull-up resistors convert the sensor outputs to logic levels. When the output from either flow sensor changes, it triggers an interrupt routine in the IC.

It measures the period of the resulting pulses and from this computes the frequency and hence flow rate. The difference is displayed on two multiplexed, 4-digit, 7-segment LED displays.

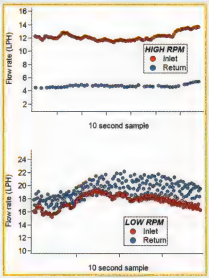
These are common cathode displays and the cathodes are driven by NPN transistors from outputs PC0-PC5 and PB2-PB3 of IC1 (pins 23-28 and 16-17), while the anodes are driven by outputs PD0-PD1, PD4-PD7 and PB0-PB1 (pins 2, 3, 6 & 11-15). The display brightness can be changed by modifying the software to alter the LED duty cycle.

By default the upper display shows the instantaneous flow rate and the lower display shows the total volume (ie, the integral of the flow rate over time) since power has been applied. The source code can be modified to show different figures if desired. For example, one display could instead show the instantaneous flow or total volume from either the inlet or return sensor.

Jaycar Cat. ZD-1202 flow sensors can be used with this circuit but only for liquids such as water. A version of this sensor that is rated for use with fuel (gasoline, diesel etc) is available from the same manufacturer. These sensors contain paddle-wheels which turn as the liquid flows. They are well-calibrated, as is required for accurate differential measurements.

The power supply is simple, consisting of a fuse, power switch, 7805 linear regulator and a number of bypass capacitors. The supply voltage can be 7-15V but the 7805 may require a heatsink for supplies above 9V. Higher supply voltages (up to 35V) are possible with a larger heatsink.

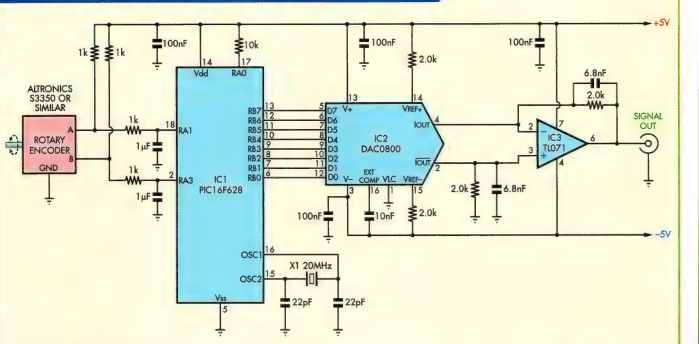
An 8MHz crystal (X1) provides the instruction clock for IC1 as well as a timebase for flow measurement.



These graphs show the fuel flow rates from the two sensors. At low RPM, the return sensor readings are erratic and must be smoothed by the software.

The source code (designated *Fuel flow circuit.zip*) is available from the SILICON CHIP website.

Craig Polley, Kensington, NSW.



PIC-based direct digital synthesiser

This simple DDS circuit is capable of generating a sinewave of between 2.8Hz and 44kHz in 2.8Hz steps. It was designed for people who wish to experiment with digital synthesis.

The main components are: IC1, a PIC16F628 microcontroller; IC2, a DAC0800 digital-to-analog converter (DAC) with current outputs; and IC3, a TL071 JFET-input op amp.

The output frequency is controlled by a rotary encoder. It is initially 2.8Hz and is increased by turning the rotary encoder clockwise. A 16-bit phase delta value is computed from the frequency setting and this is accumulated over time to determine the phase for the sine output. The sine value is then determined from this and converted to an 8-bit integer to drive output port RB (pins 6-13).

These outputs in turn drive an internal R-2R resistor ladder in IC2 (DAC0800). This results in a differential current flow between Iout and Iout-bar (pins 4 & 2). Op amp IC3 is configured as a current-to-voltage converter and this results in a sinewave voltage swing at the output socket.

The 6.8nF capacitor in parallel with the 2kΩ feedback resistor for IC3 forms a low-pass filter with a roll-off point of about 21kHz. This removes most of the high-frequency artefacts due to the finite steps of the DAC output, which occur at the 44kHz sampling rate.

This is the "reconstruction filter" and it changes the stepped output into a smooth sinewave. As a result, the switching harmonics are all below -50dB in the output signal.

The encoder signals which control the frequency are de-bounced by RC filters consisting of 1kΩ resistors and 1µF capacitors. One of IC1's internal comparators is used to detect the encoder pulses. As a result, the frequency only changes by one step for every two pulses. If desired, the software can be changed to use a second comparator so that the frequency changes on all rotary encoder pulses.

The circuit runs from a ±5V split supply. Note that rather than using the DAC0800, it is possible to build an 8-bit R-2R resistor network from discrete 1% resistors. This will have acceptable performance and is cheaper than the IC but is more work to assemble.

The software and source code (*PIC16F628A-DDSVFO.zip*) can be downloaded from the SILICON CHIP website.

Brenton Schulz,
Dudley, NSW. ($50)

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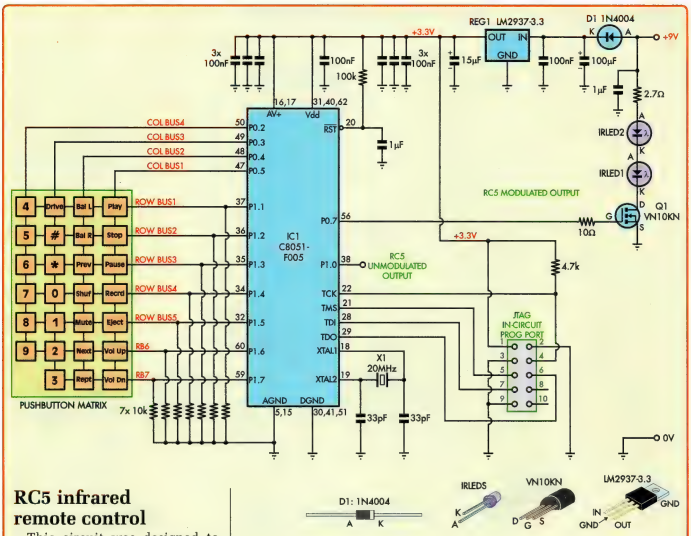


RC5 infrared remote control

This circuit was designed to control the Playback Adaptor for CD-ROM Drives (SILICON CHIP, November and December 2007). If a button is pressed on the keypad, an appropriate RC5 command is transmitted by two infrared LEDs.

The CD-ROM Adaptor can be customised to recognise any RC5 command, so custom commands are used in this application. For other applications, the source code can be modified to determine which command is sent for each button.

The circuit is built around IC1, a C8051 microcontroller. The keypad pushbuttons are arranged in a matrix with each button in a column being connected to one of the output ports P0.2 - P0.5. The other side of the buttons in each row is connected to input ports P1.1 - P1.7, with a 10kΩ pull-down resistor in each case.

The microcontroller scans the columns by bringing each of the P0.2-5 ports high, one at a time. If a button in that column is being pressed, the associated input port (one of P1.1 - P1.7) will be pulled high. By comparing which input and output is high at any given time, the microcontroller knows which button has been pressed.

The RC5 infrared code for that button is loaded from an internal table and then output P0.7 (pin 56 of IC1) is modulated at 36kHz with a suitable pattern. This drives Mosfet Q1 which powers the two infrared LEDs, which are connected in series. The 2.7Ω series resistor limits the current through these LEDs.

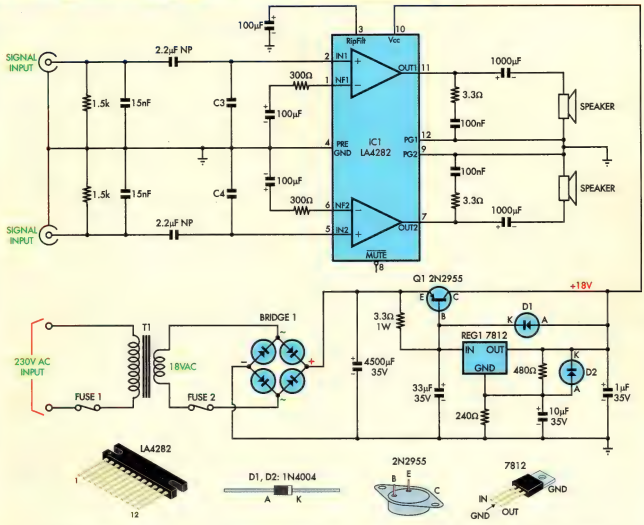
The instantaneous current is quite high but because they are modulated, the average is below the specified limit.

The RC5 infrared remote control protocol involves transmitting 14 bits of bi-phase mark coded data (also known as Manchester encoding), using a 36kHz carrier with 64 cycles for each bit. This means that at any given time, the output at P0.7 is either off or transmitting a 36kHz square wave. For debugging purposes, unmodulated output data is available at output P1.0 (pin 38).

Crystal X1 provides the clock for the microcontroller as well as timing for the 36kHz carrier frequency, via an internal divider in IC1. The power supply is simple, consisting of a 1N4004 diode for reverse polarity protection, an LM2937-3.3 low dropout regulator to power the microcontroller and a number of bypass capacitors to filter both the 9V and 3.3V supply rails.

The microcontroller firmware source code can be downloaded from the SILICON CHIP website (*rc5-switches.c*).

Ben Lennard,
Wellington, NZ. ($60)



Power supply for salvaged amplifier

The power supply shown here (lower half of diagram) is designed to drive mono or stereo audio amplifiers salvaged from defunct CRT television sets. These are adequate for driving small to medium "multimedia speakers" for use with a PC. Many TVs use either the LA4282 stereo amplifier IC (as shown in the upper half of the diagram) or the mono AN5265 IC.

The supply to power these salvaged modules consists of a fused 18VAC mains transformer rated for at least 1.5A on its secondary, followed by a bridge rectifier, a 4700µF filter capacitor and a current-boosted linear regulator. This results in a high current, regulated 18V supply for the amplifier.

The regulator circuit is based on a standard 7812 linear regulator IC. Its output voltage is increased by the addition of a voltage divider consisting of 480Ω and 240Ω resistors. The regulator adjusts its output current so that 12V appears between its OUT and GND terminals. This means that 25mA flows through the 480Ω resistor. If we assume that the regulator ground current is negligible in comparison, then the same current must also flow through the 240Ω resistor, resulting in 6V across it. Therefore the regulator output is 18V above the circuit ground.

The 10µF capacitor bypasses this 6V potential, improving the regulator's ripple rejection. D1 and D2 protect the regulator from the charge in the 10µF and 1µF capacitors in case there is a short at its input.

The 7812 IC is rated for up to 1A but this is not enough for a stereo 10W amplifier IC, so Q1 is used to increase the output current. A proportion of this current flows through the 7812 regulator and also through the 3.3Ω resistor in series with its input. As the current through this resistor increases, so does the voltage drop across it. Once the output current is above 200mA, this voltage exceeds Q1's Vbe (about 0.6V).

At this point, Q1 turns on and also begins delivering current to the output. The greater the current drawn from the output, the higher the voltage drop across the 3.3Ω resistor and the more current Q1 supplies.

In fact, Q1 supplies most of the output current for currents above 2A. Its TO-3 package can dissipate a fair amount of heat but it is a good idea to fit a small heatsink, especially in applications which may require more than 2A.

Ron Groves
Cooloola Cove, Qld. ($45)

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Dual voltage version of charger

I am considering building the battery charge controller from the April 2008 issue of SILICON CHIP. I was wondering if it is possible to make it dual voltage (ie, 12V & 24V) or do you have a dual-voltage version in mind? Most most commercially available chargers are mainly one or the other. (J. G., via email).

● Yes it is possible to make the controller dual-voltage. Resistor R1 should be switched in value to 51kΩ for the 24V version. Use a 150Ω 0.5W resistor for the feed resistor from diode D1 to the 24V zener diode ZD1.

These can be switched using a double pole double throw (DPDT) switch to change between the 12V and 24V settings.

Dimmer touch plate needs cleaning

I have built the Touch/Infrared Dimmer project (SILICON CHIP, January & February 2002) and have problems with the touch plate input constantly triggering. I have carefully checked my work and have 5V at the micro. The dimmer does work if I remove the touch plate and touch only the contact screw. Any help would be appreciated. (D. W., via email).

● The plastic plate requires cleaning. Remove the touch plate and wipe the plastic plate with a cloth to remove any film or residue that may be present. Any coating on the plastic will conduct and cause the dimmer to constantly cycle on and off in a similar way to if a hand is held on the touch plate.

Regular cleaning is necessary to keep the plate clean.

Router ignores the WIB

I completed construction of the WIB kit (SILICON CHIP, November & December 2009, January 2010) and would like to say that it is an excellent project and quite straightforward to build. I set it up as per the instructions and it works perfectly. It is connected to my home network and accessible from my web browser, however it is not recognised in the list on my network router.

My ISP is Bigpond and the modem/router is a 2-wire ADSL gateway. Any other device shows up on the list when I connect it to the router. The router has four LAN Ports and wireless, with two ports connected and three wireless laptops. All are recognised except for the WIB.

My question is, should the router table include the WIB when connected? (J. C., Branxholm, Tas).

● Depending on your router, it may show up or not. For some routers, it will not show up if the WIB is set up to use a static IP address – which is the way we have recommended in the magazine article. It may be that your router is only showing the devices that use DHCP. Therefore, it makes sense that the WIB is not showing up because we have recommended a fixed IP address.

Timer substitute for fan control

I have a fan and the timer has stopped working in it. I was wondering if there is a timer that I could connect inside the fan housing that I could control by a remote control. (M. M., via email).

● The Remote Control Light Dimmer module featured in the April 2009 issue could be used, with the

Reducing The Battery Shutdown Threshold For Ultrasonic Anti-Fouling

I have purchased two Ultrasonic Anti-Fouling kits (SILICON CHIP, September & November 2010) and would appreciate your recommendation on changing the battery monitoring circuit to an 11V cut-out instead of 11.5V. The reason for this is that if other high-current accessories in the boat are drawing power and say, the electric toilet is flushed (along with the slight voltage drop on the 10-metre cables to the transducer drivers), the 11.5V threshold may be breached. (B. W., McMahons Point, NSW).

● Low voltage shut-down occurs when the voltage at pin 5 of the microcontroller is below 3.833V and operation is restored at above 4V. With the 20kΩ and 10kΩ divider resistors that are used to reduce the battery voltage, 3.833V is reached at pin 5 when the battery voltage is 11.5V. Similarly, operation is restored at a battery voltage of 12V.

The resistive divider can be altered to change the low-voltage shut-down For an 11V shut-down, the 20kΩ resistor at pin 5 is reduced to 18.857kΩ by placing a 330kΩ resistor in parallel with it. Operation will be now be restored when the battery voltage is 11.54V.

However, while you can change the battery protection threshold, it's not a good idea. For a start, while the anti-fouling unit may stop operation while a toilet is flushed or a bow thruster etc is operated, this will only be temporary and operation will be restored as the battery voltage rises back to normal levels. This is unlikely to have any long-term reduction in anti-fouling effect.

More importantly, by setting a lower cut-off point, you will be more deeply discharging your batteries and this will definitely reduce their overall life expectancy. This is undesirable since boat batteries are so expensive.

Compact 12V 20W Amplifier Cannot Be Paralleled

I'm referring to the May 2010 article written by Nicholas Vinen, "Build A Compact 12V 20W Stereo Amplifier". This is an excellent amplifier but I am trying to find out if this design can be paralleled, as in **http://en.wikipedia.org/wiki/Bridged_and_paralleled_amplifiers#Paralleled_amplifier**

I intend to use it to power a 2-ohm mono subwoofer in a car but according to Nicholas' article, the amplifier can only drive a 4-ohm load. The only way I can do this with a 2-ohm subwoofer is to parallel the input and output, which will raise the load to a 4-ohm equivalent. I'm hoping this design can be used in this way and if so, will it require resistors on the outputs for proper current sharing? (G. K., via email).

● The 12V Stereo Amplifier can drive 2-ohm speakers but not in bridge mode, which is how it is normally used. You would have to connect the speaker between one amplifier output terminal and a ground point on the PC board. That will work but you will only get 10W.

In this mode you can even drive up to four speakers but you would need to reverse the speaker(s) connected to the inverting outputs so that they are all in phase.

Regarding the possibility of paralleling the amplifier stages to deliver more power or to handle lower load impedances, while it is theoretically possible it is not very practical.

The first problem is the output DC offset of the amplifiers. The TDA7377 data sheet specifies the maximum output offset voltage as 150mV. In the worst case, if one is +150mV and the other is -150mV, there would be 300mV between the outputs. In practice, we measured 120mV and 95mV between the two channel pairs on our prototype.

This means that if you use 0.1Ω resistors to connect each output to the speaker, approximately 120mV/0.2Ω = 600mA would flow between them with no signal. This would result in around 8.4W of power dissipated per channel pair, or around 15W in total. Given that the total output power of the whole amplifier will be around 40W, this is an unacceptable loss.

We could reduce this by increasing the resistor value but this is impractical, since at full power each amplifier channel can deliver around 5A RMS, meaning that even with 0.1Ω resistors we could be looking at 2.5W dissipated in each of the four resistors. A 0.22Ω resistor would need to be rated for at least 10W and there would still be 7-8W of dissipation in the amplifier even at idle.

Then there is the issue of gain mismatch. This makes the problem even worse because the DC voltage between the amplifier outputs will become even greater as the signal swings further from ground unless the gain is very well matched between the amplifiers within a pair.

There is a way to solve the DC offset problem which is to include a capacitor in series with one of the amplifier outputs. This would need to be a high-value capacitor (say, 4700μF 16V) and since there would be little to no polarising voltage across it, it would be necessary to use four such capacitors, in two parallel pairs, with the two pairs connected cathode-to-cathode (or anode-to-anode) to form a non-polarised capacitor. This could get quite expensive and it does not solve the gain mismatch problem.

Ideally you would be able to trim the gain between each amplifier pair and then this solution would be practical. Since the gain of the TDA7377 is fixed, that is not possible with this design.

We think a much better solution would be to use a 4-ohm, twin-coil subwoofer such as the Jaycar CS-2351 or CS-2353. In this case you could simply connect the two voice coils to the two amplifier outputs, tie the inputs together and then you would get the full 40W output without all of the problems described above. Unfortunately, if you already have a 2-ohm subwoofer speaker, this advice may not be helpful to you.

By the way, in March 2002 we published the "Mighty Midget Class-H Audio Amplifier" (which also uses an audio amplifier IC) but it delivers

timer option enabled. The dimming function would be set at the fastest rate so the fan is either switched on at maximum or set to off at the end of the timer period.

Ultrasonic anti-fouling for a large catamaran

I want to install ultrasonic anti-fouling, as per the September & November 2010 issues, in my 13.1m catamaran (waterline length 13.1m). Will I get away with one unit in each hull and what would be the ideal position for the transducer?

I'm prepared to install two units if one will not be adequate for each hull. I am aware that your article stated that the transducers were not suitable for foam sandwich construction, which this boat is. I intend removing the inner laminate and foam from the area where the transducers will be installed and glassing from the inner laminate onto the outer laminate, giving a solid glassed area for the transducers to be adhered.

Would this then work? This is dramatic stuff removing foam etc hence I want to be confident that they will work in the designated areas and not turn the hull into Swiss cheese. (G. M., via email).

● We would be very reluctant to do what you propose and very much doubt whether it would work anyway. Coupling to the hull is one problem but even if you accomplish that, the ultrasonic vibrations would be prevented from propagating throughout the hull structure by the damping of the foam sandwich construction. It may be possible to protect the boat when it is at rest by having ultrasonic transducers hung outside the hull and aimed back to the hull.

This is only a theory at this stage and it may work along the same lines as algae suppression in ponds and pools using an ultrasonic transducer suspended below the surface of the water. For the time being though, we just don't have a solution. Sorry.

more power, with higher distortion. For a subwoofer, the Mighty Midget is the better amplifier to use due to the increased power delivery and in this application the distortion is not critical. For driving the normal range of speakers (tweeter, midrange, woofer), the more recent design is better since it has much lower distortion and adequate power delivery.

Unfortunately, the Mighty Midget kits have been discontinued and the TDA1562Q IC is now difficult to obtain. As a result, we are considering developing a new project with similar capabilities, using a different IC.

We initially expected the offset voltage between the two amplifier outputs to be closer, since the amplifiers are all fabricated on a single silicon die. However, we suspect they do not trim the output offset as it is not considered to be a critical performance parameter for that chip.

If we built a discrete amplifier then we could trim the output offset and gain so that they match very well. Resistors (and possibly capacitors) would still be necessary to force current sharing but then it would be realistic to parallel the outputs.

Keep in mind that the Mighty Midget is a single-channel bridged design so you would need two boards to drive a twin-coil 4-ohm subwoofer. In that case, you would get up to 72W which is pretty good from a 12V supply. You could use a single Mighty Midget to drive a regular 4-ohm subwoofer or possibly just drive one of the coils in a twin-coil speaker.

Speed controller for induction motor

Have you ever thought about making a variable-frequency speed controller for induction motors? You have made one for brush-type motors but not induction motors.

I want to reduce the speed of a washing machine motor. If I use your latest brush type controller I would burn the motor out in no time. The only other way you could reduce the speed is to use inductors or start-up capacitors in series with one line.

Commercially-made units cost thousands of dollars. I would make one myself if I knew how. I guess it would

Compact 12V 20W Amplifier Cannot Be Bridged Either

Is it possible to bridge the two outputs of the 12V Stereo Amplifier (SILICON CHIP, May 2010) to make one higher-powered mono amplifier? I read the article on the amplifier and the one on the chip itself but this was not mentioned. I would have thought it would be a common requirement.

I'm pretty well aware of things like the impedance that you'd have to run the bridged amplifier into so a simple "yes" or "no" answer will suffice. (J. T., Concord, NSW).

● You cannot use the the Mini 12V Stereo Amplifier in bridged mono mode to get more power because it is already using bridged mode for its four internal amplifiers to drive the two speakers.

If you want to get more power you really only have two choices: either increase the power supply voltage or use a lower impedance speaker. The amplifier will definitely deliver more power if you run it off 16V DC (or if you have a very well regulated supply, up to 18V). Of course, this is easier to do if you are using a mains supply rather than a battery.

Alternatively, a DC/DC (boost) converter could be used to get a higher voltage from a battery and thus achieve greater output power.

As mentioned in the article, it is not recommended to use a lower speaker impedance than 4Ω because the chip is not rated for it. It may tolerate 3.2-ohm speakers but there is no guarantee and the short-circuit protection would not activate at high power levels.

Nor Will It Pull High Currents With Music Signals

I have finished building the 12V Stereo Amplifier (May 2010) and it sounds great. However, in the article it states the current drain using 4-ohm speakers could be up to 6A.

I am running it on the bench in my workshop (3 metres square) using my benchtop power supply and at a comfortable volume it draws less than 200mA. At full volume which is still not too loud the current is still under 1A.

I am driving it from the speaker jack on my laptop using the "Ultimate Jukebox". Is this signal level too low? Also, because I am using the speaker jack, the grounds of the inputs are shorted together. Is this a problem? (P. C., via email).

● You will not be able to get it to draw 6A continuous unless you are driving the amplifier to the full 20W per channel with a resistive load and a sinewave signal.

If you are driving both channels of the amplifier to full power into 4-ohm loudspeakers, again with a sinewave, the chances are that the amplifiers will not be delivering 20W unless the speaker impedance happens to be exactly 4Ω at the sinewave frequency.

So it is unlikely to pull 6A under that condition.

Of course, we do not listen to pure sinewave signals. We listen to music and even if we are listening to heavily compressed rock music, it will still have a reasonable dynamic range of more than 20-30dB, so the average power level will be far less than 20W per channel.

The reason we specified a power supply capable of 6A is that if you want to guarantee that the amplifier can deliver maximum bass on those drum crescendos (or whatever), you need that peak current capability.

So yes you can probably get away with a much smaller power supply if you aren't going to push it too hard. If you drive it hard enough with a smaller supply you run the risk of unpleasant "motor-boating" behaviour which results in a "thump, thump, thump," sound from the speakers.

As stated in the article, the input sensitivity is around 250mV RMS. In other words, this is the signal level required to deliver maximum power. Chances are your laptop can provide enough signal to drive it to full power if its output volume is turned up to maximum.

Having the input grounds shorted together is not likely to be an issue in the applications where this amplifier will typically be used. It can certainly be used with a phono-to-dual-RCA cable which makes that inevitable.

Choosing An Inductor For The TL499A Step-Up Regulator

Is there a specific type of inductor that is recommended for the TL499A when using it as a step-up regulator (1.5V to 5V)? When it is used in the magazine, toroidal types are used. I want to substitute a smaller inductor due to space limitations. Is the Element14 (Farnell) 1635799 suitable or do you know of any others that would do the job?

One more thing that's been bugging me, do resistors increase their overall wattage if placed in series or parallel? For example, three 4Ω 2W resistors in series effectively become 12Ω @ 6W or similarly, two 4Ω 2W resistors in parallel effectively becomes 2Ω @ 4W. Which one is correct? (B. W., via email).

● The TL499A requires an inductor of between 50µH and 150µH rated up to 500mA and a DC resistance of less than 0.1Ω. The particular inductor you refer to is 47µH and 1.3A with a 0.1Ω DC resistance. This will probably be suitable although it is below the inductance range for the TL499A. A 100µH value would be better to use.

Resistors placed in parallel or series both provide for increased power dissipation since the power is shared between each resistor. If each resistor is the same value, then the power dissipated is shared equally between each resistor.

The difference between the parallel and series connection is the way the resistance is totalled. For series resistors the total resistance is the sum of the series resistor values. For parallel connections, the resistor values are each divided into 1 (inverted) and then these inverse values added. The total resistance is then the inverse of this total. For equal-value parallel resistors, the total resistance is the value of one resistor divided by the number of resistors in parallel.

Both your examples are correct.

contain a microcontroller. You could make a single phase and a 3-phase 20A controller. Have a think about it. I hope to see one at the end of the year or next year. (S. W., Murwillumbah, NSW).

● We have had quite a few requests for a variable-frequency speed control for induction motors but we have been reluctant to produce such a design since it is a very complicated exercise and the resultant unit will be quite a dangerous circuit for novices to work on. Commercial units are very expensive, partly because they are designed to cope with a wide range of induction motors and need to cope with very heavy in-rush currents when the motor is starting.

There are Mosfet 3-phase H-bridge chip sets available which need to be driven by a microcontroller but they are not directly adaptable to a single-phase design. On balance, we still think that a safe and reliable speed controller for induction motors will be too expensive for us to develop as a kit project. Sorry.

Ultrasonic anti-fouling & ferro-cement hulls

Is the ultrasonic anti-fouling project suitable for boats with ferro-cement hulls? This is not mentioned in the articles. (J. E., Concord, NSW).

● This project is definitely not suitable for ferro-cement hulls. This is mentioned in the Q&A section on page 86 of the November 2010 article. However, while we also stated that the system was suitable for metal hulls such as aluminium, we did not specifically mention steel hulls. So, let's put that right and state that it also works with steel hulls.

Australian mains voltage is 230VAC

I've recently got back into purchasing and reading Silicon Chip. I like the articles and the variety and accuracy of information. Something that has been catching my eye is that any project in your magazine involving mains shows the mains voltage as 230VAC.

At first I thought why are they making that mistake as I was still under the impression that the Australian Standard for mains was still 240VAC. However, after looking on the internet at sections of the Australian Standard this was apparently changed to 230VAC to conform with European Union standards as of the year 2000. I also noted that this would have little effect on the end user as the tolerance range still allows for a fair voltage range, including what we were used to in terms of 240VAC ±10%.

The reason I'm writing is I wasn't aware we'd officially changed mains voltage. Was this publicised at the time? I was an apprentice at a TV repair shop from 2005-2008 and worked there part-time from 2002.

I still work in the electronics industry, working on broadcast communication equipment. Through all that time working on consumer electronics and attending trade school and even until today I don't ever recall hearing about a change in the standard. (D. A., Shepparton Vic).

● As of 2000, the mains supply voltage specified in AS60038 is 230V with a tolerance of +10% -6%. This was done for voltage harmonisation – however 240V is within tolerance and is still widely found. "Harmonisation" is supposedly to make our mains supply more compatible with overseas-sourced equipment.

In fact, many if not most areas still have a voltage around 240VAC. There was a Publisher's Letter on this topic quite a few years ago. We think it was a silly move as it actually reduces the efficiency of the national grid.

24V water-pump controller

We are interested in using your 20A Motor Speed Controller (Silicon Chip, March & April 2008) to control the Craig Davies water pumps in a 24V marine installation using two 24V pumps, as we have keel cooling. Your 20A Speed Controller appears to be the best solution. Do you have a circuit modification to allow a 2-terminal thermistor to control the unit?

The marine sensor thermistor we have is typically 300Ω at 20°C and 50Ω at 100°C. My friend also wants to use it on 24V Nissan off-road vehicle. (D. B., via email).

● Presumably, you wish to increase the drive to the pump motor as temperature increases. The thermistor could be used as one section of a voltage divider across the 5V supply with

the junction of the divider connected to pin 2 of IC1 instead of the speed potentiometer. The thermistor would then connect between pin 2 and the +5V supply and a resistor (Rx) connects between pin 2 and the 0V rail.

Note that these connections are available at the potentiometer terminal connections on the PC board and the potentiometer is removed. The value of the resistance Rx in series with the thermistor would have to be determined as it sets the rate at which the motor responds to temperature change. A typical value would be 100Ω 0.5W. A larger value would have the pump run faster.

A more complex resistor network may be required if the speed control range is too wide. For example the 10kΩ speed pot could be left in circuit and the thermistor connected with one terminal to the +5V rail and the other to a resistor Rx. This resistor's other lead would then connect to 0V.

The connection between the thermistor and resistor Rx then goes to the speed potentiometer wiper (centre terminal) via another resistor that is around 10kΩ.

The initial speed of the motor is then set by the speed pot, with temperature control by the thermistor. As temperature rises, the thermistor resistance falls and the wiper of the pot is pulled towards 5V via the 10kΩ resistor to increase speed of the motor. Rx may need to be determined so that the speed changes appropriately. The 10kΩ resistor sets the control range.

Preamplifier for magnetic cartridges

I am in need of a small preamp to boost the voltage to line level to drive the input into an Apple computer via "iMic" – see **www.griffintechnology.com/support**

iMic is a small in-line analog to digital converter. I would be very much obliged if you can help, as my large class-A amplifier has spat its dummy. (J. J., via email).

● We are not sure whether you want a preamplifier for a magnetic cartridge (as per the subject line of your email) or whether you require a preamplifier for the Griffin iMic (as per the rest of the email). Is it that the iMic does not have sufficient gain for your application and so you need additional amplification or are you attempting to convert your vinyl records to digital or both?

According to the Griffin website; "iMic allows you to connect microphones and other input devices to your iBook, PowerBook, PowerMac or other Mac or PC systems. All you need is a USB port. iMic supports both mic and line level inputs via a selectable switch, and provides a line-level output for connecting speakers or headphones.

"iMic shines as the essential tool for converting your vinyl LP and tape collection into MP3s and CDs. Recording records and tapes through iMic directly from your turntable or tape deck is super easy. Use your own favourite recording software, or use our software for free. For Mac users, we provide Final Vinyl as a free download. Final Vinyl is designed specifically for converting your vinyl collection to digital. It comes with advanced features such as waveform-based cue editing, and 10-band EQ, and even includes a special RIAA filter that properly equalises LPs without having to connect your turntable to a pre-amp. For PC users, we suggest the popular open-source, full-featured recording application, Audacity."

For vinyl recording we recommend using the appropriate RIAA preamplifier since this has the correct response for a magnetic cartridge signal from a vinyl record. Without the RIAA preamplifier, the lower frequencies will be be too low in level for satisfactory conversion to digital after the treble frequencies are boosted to provide line levels. Using a digital RIAA filter within the iMIC software or using equalisation will not provide a high signal-to-noise ratio and

. . . continued on page 103

Notes & Errata

Dual Tracking Supply, June-July 2010: under some conditions, if the supply is switched off then on again soon after, the negative output current sense display may not operate correctly. To solve this, a 1N4148 or 1N4004 diode can be soldered between the output of IC2a and ground, with the anode to ground. This can either be soldered to the underside of the main PC board or to the electrically connected pads on the rear of the front panel board.

Wien Bridge Oscillator, Circuit Notebook December 2010: the RC components wired to S1a are shown to be connected to +12V when in fact they should be connected to the lefthand side of the lamp at half the supply voltage.

USB Data Logger, December 2010: in order to support baud rates greater than 57.6kbps (ie, up to 0.5Mbps), change the two 100nF monolithic capacitors on the A0/D4 and A1/D5 inputs to 10nF.

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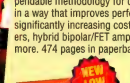

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Ask SILICON CHIP – continued from page 99

the results are likely to be poor.

Best results are obtained when using an RIAA preamplifier such as the Magnetic Cartridge Preamplifier published in August 2006.

Radio sports commentary delay

With the cricket season now underway, the preference for many people to watch "live" matches on TV whilst listening to the commentary on radio is again a topic of frustration because the TV stations delay the broadcast to prevent people from doing this. A suggestion for a project to circumvent this restriction would be for a small unit to be fed from a headphone/speaker output with a variable delay to enable the user to synchronise the audio with the video.

The circuitry would probably be quite simple using "bucket brigade devices" or their modern counterpart. Possibly an amplifier stage could be incorporated to directly drive a speaker unit. (M. J., via email).

● We don't think the TV networks actually delay the sports broadcasts to prevent people listening to radio commentary. What is more likely is that you are watching the broadcasts on a large screen plasma or LCD set and inevitably the digital video processing occurring in your own set is the problem. A similar problem often occurs with sound sync between video and audio when a large screen set is part of a home theatre set-up.

It would certainly be possible for us to design a suitable delay circuit, possibly based on a dSPIC processor. We will have a look at the possibility.

Combining generator outputs

I have built a permanent magnet generator that has two independent AC circuits, one at 400V and the other at 200V. I need to combine the two outputs so that only one lead issues from the generator. As the circuits are out of phase, what can I do? (A. H., via email).

● On the face of it, you cannot combine the two outputs in parallel, since they have different voltages. If you want to add the voltages, and assuming they are 180° out of phase, you can connect the two outputs in series but you will need to get the polarity right to provide addition of voltage rather than subtraction.

Megohm meter has incorrect test voltage

I have just completed building the Digital Megohm & Leakage Current Meter from scratch. When turned on for the first time the LCD showed the correct dialog etc and all looked fine. I connected the test wire and commenced the setting-up process and the 1000V reading showed 103μA. Not to be out-done I adjusted the trimpot but this had no effect on the reading.

I changed to the 500V setting and the reading was 53-56μA with the last digit flashing between what looked like "3" to "6" when the test button was pressed. I checked the voltage at test points TP3 (2.48V) & TP 1 (3.18V) and replaced trimpot VR1, thinking it may be faulty but it gave no improvement.

The meter works but will not allow adjustment via VR1. Also when the test button is pressed, the last two digits of the 999MΩ reading fluctuate/blink just ever so slightly. I have checked the soldering etc under magnification and cannot see any dry joints etc. Any assistance would be appreciated. (S. F., Carina Heights, Qld).

● The voltage readings you are getting are not a cause for serious concern but from your figures it sounds as if the main cause of the deviations is the slightly low voltage at TP1 and the Vref+ input of IC3. At 3.18V, this would be making the ADC read at least 2% high.

To fix this, try replacing the 270Ω resistor (in series with the 5.6kΩ resistor, from TP1 to ground) with one of 300Ω, to see if this moves the TP1 voltage up nearer to 3.20V. If it moves up too far, you could then try shunting the 300Ω resistor with a high value, to nudge it back down to the 3.20V level. SC

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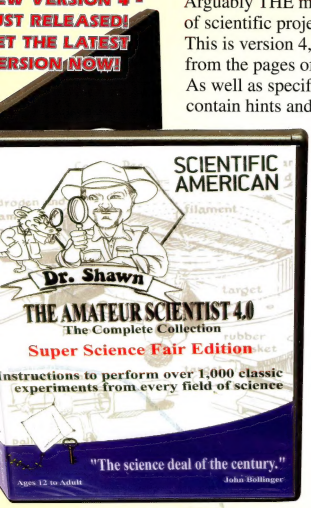

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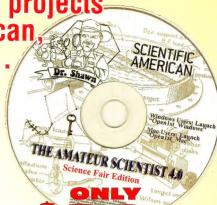

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